Electrical Engineering

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Winter Convention—New York, January 26-30

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FUTURE MEETINGS
of the
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Place	*Dates*	*Nature*	*Latest Date for Receipt of Manuscripts*
New York, N. Y.	Jan. 26-30, 1931	Winter Convention	(Closed)
Pittsburgh, Pa.	March 11-13, 1931	District Meeting	(Closed)
Rochester, N. Y.	May 6-9, 1931	District Meeting	Feb. 6, 1931
Asheville, N. C.	June 22-26, 1931	Summer Convention	March 23, 1931
Lake Tahoe, Cal.	Aug. 25-28, 1931	Pacific Coast Convention	May 25, 1931
Kansas City, Mo.	Oct. 22-24, 1931	District Meeting	July 22, 1931

NOTE: Members who are contemplating submitting papers for presentation at any of the above meetings should communicate promptly with Institute headquarters, 33 West 39th Street, New York, N. Y., so that their papers may be docketed for consideration by the Meetings and Papers Committee, as programs for all meetings are formulated several months in advance. Upon receipt of this notification, Institute headquarters will mail to each prospective author information in regard to the Institute's rules relating to the preparation of manuscript and illustrations.

MEETINGS OF OTHER SOCIETIES

American Engineering Council, Annual Meeting, Mayflower Hotel, Washington, D. C., (L. W. Wallace, 26 Jackson Place, Washington), January 15-17, 1931.

National Electrical Manufacturers' Association—Midwinter Meeting, New York headquarters, (A. W. Berresford, 420 Lexington Ave., New York), January 19-23, 1931.

The American Society of Civil Engineers, Annual Meeting, Engineering Societies Building, New York, N. Y., (G. T. Seabury, Secy., 25 West 39th Street, New York), January 21-23, 1931.

Midwest Power Engineering Conference, Chicago, Illinois (G. E. Pfisterer, 308 W. Washington Blvd., Chicago), February 10-13, 1931.

The American Physical Society, 169th Meeting, New York, N. Y. (W. L. Severinghaus, Columbia University), February 27-28, 1931.

American Institute of Mining Engineers, Annual Meeting, Engineering Societies Building, New York, N. Y. (H. Foster Bain, Secy., 25 West 39th Street, New York), February 16-19, 1931.

National Electric Light Association, Engineering Section, Minneapolis, Minn. (J. W. Lapham, 803 Plymouth Building, Minneapolis), February 23-24, 1931.

American Electrochemical Society, Birmingham, Ala., April 23-25, 1931.

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The ever-alluring night-time skyline of New York City; Manhattan as it appears from Governors Island.

—Photo by Underwood & Underwood

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WINTER CONVENTION program presents a wealth of technical papers of timely importance, and offers opportunities for intensely interesting inspection trips. (See page 50)

◆

NATIONAL OFFICERS for 1931 were nominated Dec. 5, 1930, by the national nominating committee, meeting at Institute headquarters, New York. Fifteen delegates were present, representing every geographic district. (See page 53)

◆

ENGINEERING INDEX review service covering 1,800 current technical periodicals is inaugurated in this issue with a listing of electrical engineering references. (See page 64)

◆

LICENSING OF ENGINEERS is one of the subjects to be studied by a recently enlarged professional committee headed by H. A. Kidder. (See page 53)

◆

CHARLES GORDON, executive secretary of the American Electric Railway Association and thoughtful student of urban transportation problems boldly recommends less attention to new streets for automobiles and decidedly more attention to more tracks for better street cars. (See page 4)

◆

EDUCATORS AND INDUSTRIALISTS, in a two-day session at Lehigh University, revealed differing viewpoints as to what constitutes a suitable technical education. Much information of value to technical students came out of the discussions. (See page 8)

◆

DR. JOHN B. WHITEHEAD, energetic leader in the field of insulation research and dean of the Johns Hopkins University engineering school, is making noteworthy progress in his efforts to find common ground for the proponents of conflicting theories. (See page 24)

◆

AIRWAY BEACONS in out-of-the-way places now may be lighted directly from high-tension transmission lines according to F. W. Cartland of the Westinghouse company who describes equipment and methods. (See page 31)

◆

FRANK E. Bonner, executive secretary of the Federal Power Commission, outlined the major functions of the commission in speaking before the recent annual meeting of the American Society of Mechanical Engineers. (See page 35)

"Electrical Engineering"

EVEN before you opened this issue of the monthly publication of the Institute you noticed a change. As you proceed through the pages you may sense more departures from the "Journal" of the last few years.

ALL this is part of an evolutionary scheme to enlarge the value of the Institute to every member regardless of age, location, responsibility, interest in the field of electrical engineering or in its professional significance. To bring the engineer to the Institute obviously is too costly in time and money; therefore, every effort is being made to bring the Institute to its members. Toward this end some years ago Sections were instituted and more recently District meetings were promoted to decentralize activities and render the national atmosphere frequently accessible to members everywhere. Now, as a next step, the monthly publication revises its format, and essays to interpret the latest technical developments and other matters of professional interest more in accord with the broad requirements of the whole membership.

IF these changes arouse in you a happy appreciation you surely will want to impart it to some hesitating applicant. Or, you could help the editor by telling him. In fact, why not tell him anyhow? This is your Journal and you have that privilege and duty.

W S Lee

President.

THIS, the first issue of ELECTRICAL ENGINEERING, marks another important step in the development of the American Institute of Electrical Engineers. Under this new and more appropriate title, the successor of the Journal of the A. I. E. E. will be published monthly as the official organ of the Institute, but with a much broader scope.

THE survey made during the past two years by the Publication Committee, under the able chairmanship of Mr. W. S. Gorsuch, clearly indicated a very general demand that the Institute continue to publish a high-grade electrical engineering periodical including, however, not only engineering and scientific papers and discussions presented at the various Institute meetings, but also much additional matter reflecting current progress in the art of electrical engineering.

ORIGINAL papers on theoretical or experimental investigations, important inventions, discoveries and developments in the fields of electrical engineering and the related sciences, will continue to constitute the major portion of the contents. The high standard that always has been maintained in the Institute's publications will be continued. Based upon the constructive work of the past, the broadened scope of the publication is a logical step in the evolution of the Institute, the purpose being to supply information that will enable the individual engineer to keep more fully informed of recent developments in the theory and practise of all branches of electrical engineering.

ELECTRICAL ENGINEERING will reflect the steadily increasing part that the applications of electricity are taking in our modern civilization. More attention will be given to the effects of engineering upon human relationships; in particular, the influence of electrical engineering in the fields of sociology, economics, and other social sciences.

THE ability of the leaders in the engineering profession, for effective collective effort, has been developed to a large extent by their activities in the Institute and in similar organizations. ELECTRICAL ENGINEERING is one of the instruments established by the Institute for the exchange of ideas, and it affords the individual engineer opportunity to contribute items of interest and value from his experience for publication in exchange for the ideas which he receives from other contributors.

THEREFORE, the Publication Committee and the editorial staff will be glad to consider contributions similar in scope to those published in this issue, in which a beginning has been made in the direction indicated. It is expected that the future issues will constitute, even more fully than the monthly "Journal" has in the past, an authoritative history of developments in the electrical engineering art and the related sciences, which together constitute the basis for evolution in the electrical industry.

F. L. Hutchinson

National Secretary.

Automobiles vs. Railways for Urban Transportation

Electric power in urban transportation presents an opportunity and a challenge to the electrical engineer that is emphasized more strongly as street congestion grows worse in all centers of population. Tremendous public expenditures are being made for street improvement, but will that afford economical transportation?

By Charles Gordon

Managing Director,
American Electric Railway Association

A 1930 model street car. Designed for comfort and high speed, it is a most efficient user of street space

FUNDAMENTAL to all industrial progress lies progress in transportation. Only as man has succeeded in overcoming the limitations of distance and time has he moved forward in mastering his environment. When man learned how to substitute energy derived from wood and coal for that of beasts and of his own body, the first extended commercial applications of the new power were made to transportation. Since then, the development of each new form of power has resulted largely from the dominating importance of the need for transportation improvement. It is quite natural, therefore, that the fiercest battles for achievement and for survival of the fittest among the vanguard of mechanical, electrical and automotive engineers are still being waged in the field of transportation.

Man first applied the magic of steam to make the railroad and the steamship. With them he took his first great step in the mastery of distance and time. Improved transportation permitted rapid growth of industrial and commercial centers which were required when steam-driven machinery in turn replaced handcraft. In consequence of these two developments, civilization experienced an industrial revolution.

Steam power has enhanced the economic importance of cities. Increasing numbers of people were drawn by economic forces to rapidly growing industrial and commercial centers. Therein was born a new need—the need for improved local transportation within these urban areas. For a time animal power was sufficient for the purpose, but as population and the areas of cities grew there was need for something more efficient than animal power; and without the smoke and other limitations of steam. That need stimulated the development of electric motive power and its first major application. Local transportation in cities offered early electrical men a most important commercial opportunity; it stimulated the development of generating, motor, and control equipment. Subsequently, as had occurred with steam, transportation shared with other uses its position as the major field for application of the new power.

It seems particularly significant to electrical engineers today, as an indication of the rate at which we are moving, that the history of electric power is encompassed within the lifetimes of two men whose names stand out in its early development. Sprague, who built what is counted the first commercially successful electric railway line, and Edison, who after conducting early experiments in lighting and transportation concentrated upon applying electricity to light the world, have both been permitted by kind Providence to live to see the marvelous achievements of their early struggles.

In the transportation field, for people who were content to travel collectively, steam and electricity reigned supreme. But the horse has survived and has continued for many years to serve those who required individual transportation or desire exclusiveness. The industrial age opened as a utilitarian age. Transportation men concentrated upon utility and efficiency, when the horseless carriage first appeared upon city streets they gave it barely passing attention. They failed to recognize its significance as marking the introduction of a new form of power—the internal combustion engine—applied to individual transportation. But within three decades, the automotive vehicle has so stimulated the desire for individual convenience, speed, and luxury in travel that it congests the streets of our cities and spreads out over the land on a gigantic system of highways built by the public to make its use possible.

An address delivered at the A. I. E. E. Southern District Meeting, Louisville, Ky., Nov. 19, 1930, under the title "Electric Power in Urban Transportation."

Again, the introduction of a new form of power made for new standards of transportation. Again, far-reaching social and economic changes result. Starting with the individual vehicle, the automotive engineer has cut the ties that bound man to earth and now carries him through the air. And while he pushes rapidly forward these achievements he also challenges the mechanical and electrical engineer in a field of collective travel. He has plunged into the transportation power battle both within and between cities, and contests at many points the reign of steam and electric power, on land and on sea.

So spectacular and rapid has been the progress made by automotive power that laymen and many engineers as well are inclined to write off electric transportation in cities along with the horse-car. And although they do not go quite so far as to relegate the railroad to the limbo of the stage coach, there is a strong tendency to assume that the internal combustion engine on the highway will rapidly decrease the field of usefulness of the steam engine on rails. In the early stages of railroad electrification there was a similar tendency in the minds of enthusiasts to consign the steam locomotive to the scrap heap; nevertheless, locomotive designers met the advance of electric power and have given way to it only in high-density terminal areas and under the special conditions presented by steep mountain grades. With these exceptions the steam locomotive continues to dominate long haul transportation.

It seems particularly timely, therefore, that electrical engineers examine a little more closely the problem of transportation in urban areas where the great electrical industry had its origin barely fifty years ago; and where, in turn, predictions are freely made that electric power will be replaced by the internal combustion engine. In this examination we shall need to concern ourselves as much with economics as with engineering, for it is on the scale of economics that the achievement of the engineer must be weighed and finally judged.

Before proceeding, one additional thought seems worthy of mention here; just as the automotive engineer took to the air to make further conquests of space and time in transportation, so did the electrical engineer make new conquests through the air in the field of communications. In these respective fields each reigns supreme and each one records almost daily, achievements which whet our imaginations in an effort to foresee man's next step to master his environment. It is not surprising, therefore, that the eyes and the minds of electrical engineers, as well as of the public at large, have been diverted from the relatively unspectacular field of urban transportation which gave electric power its early impetus.

Though not so spectacular and therefore less in the public eye, transportation facilities within urban areas lie at the very heart of our modern economic system, for these are points of concentration for our vast industrial and commercial machinery. Without adequate and efficient elevators the modern skyscraper would be impossible. Without an adequate circulatory system, the whole urban area in which the skyscraper and the factory, the apartment building and the department store are merely units, would cease to function; for the economic existence of these areas is dependent upon the travel facilities by which people may move conveniently between home and office, factory and store. In large measure, the economic height of the skyscraper is

Typical scene at the New York entrance to the Holland Tunnel under the Hudson River. A single track of street cars operating with seated loads would more than double the passenger capacity determined on one hand by land values, and on the other, by problems involved in providing vertical transportation. So also physical arrangement of cities as a whole, and the economic location and character of property development, are determined by land values and the facilities for horizontal transportation.

In every large city the demand for street space far exceeds the supply; in congested areas it is obviously impossible for all who would do so to move by individual vehicle. How then shall the need be met? Will it be by the construction of two, three, four or even more, levels of streets as some suggest? And if so, will these be for gasoline-propelled vehicles operating on pavements, or for electrically-propelled vehicles operating on rails?

Efficient local transportation is vital to the modern economic system. This loading terminal expedites traffic at a Detroit industrial plant

There is little question as to the public's preference at the present time. While the electrical engineer has been concentrating upon utility and efficiency with little regard for mental and esthetic values, the automotive engineer has been directing his attention to speed, attractiveness, and even luxury in the design vehicles. The result was natural and inevitable; it verified an ages-old principle that the price which mankind is willing to pay to achieve a desire is measured by the intensity of the desire and his ability to make whatever sacrifice is necessary to achieve it. The automotive engineer sensed the importance of the desire for speed, comfort and luxury in travel, and concentrated upon meeting it. As a result the public likes and wants the automobile and will not be deterred by cost alone from providing facilities for its use.

The prediction then that we shall build our cities of the future for automotive travel regardless of cost is sound in so far as it assumes that cost is secondary to popular desire. But in the light of facts it assumes that there is no limit to the price which the public is willing or able to pay to ride by automobile. It is not so much the cost to the individual to which attention should be directed—high as that may be—but the relative costs to the community, of travel by electrically propelled transit facilities and individual automobiles.

By considering the relative passenger capacity of roadways for individual vehicles as compared with the capacity of collective transportation facilities the magnitude of this problem may be grasped readily. Under extraordinary conditions, the maximum practicable capacity of a single lane of motor vehicles is approximately 1,800 vehicles per hour; this on the assumption of uninterrupted flow of passenger automobiles only, free from interference by cross traffic. For calculating traffic capacity of a street *free of all crossing interference*, the figure is high rather than low, and would represent a condition of congestion which would be neither convenient nor satisfactory to the operators of vehicles. For example, the maximum recorded traffic flow through the Holland Tunnel under the Hudson River between Jersey City and New York City occurring on May 30, 1930 was 1,253 vehicles per single lane. The ultimate capacity of the tunnel in two lanes is computed as 1,270 automobiles per lane per hour. For calculating highway capacities, let us use the figure of 1,500 vehicles per lane per hour *for a highway with no grade crossings*, which would represent the practical maximum at satisfactory speeds. Likewise, careful analysis of traffic checks taken under a wide variety of conditions indicates that approximately 900 vehicles per single lane per hour is a fair average for calculating the maximum practicable capacity of a single lane on a major arterial street or highway *subject to normal interruption of cross traffic*.

The above capacities apply only to a single lane; but roadways are not ordinarily single lanes, but consist of several lanes on which traffic weaves from lane to lane, reducing the capacity per lane as the width of the street increases. Though the exact effect of this factor of weaving upon multiple-lane highway capacity cannot be accurately measured, it can be fairly approximated and the figures below give the results to be expected under average conditions:

RELATIVE CAPACITY OF MULTI-LANE STREETS IN COMPARISON WITH SINGLE-LANE

Number of lanes in one direction	Efficiency per lane in per cent of single lane
1	100
2	89
3	79
4	70
5	62

The capacity of roadways of various widths is, therefore, readily determinable, calculation being possible under three conditions: First, express movement on a roadway with no grade crossings and no stopping; second, on a roadway such as a city boulevard subject to grade-crossing interference, but with parking prohibited; and third, a roadway with normal grade-crossing interference and with the further reduction

MAXIMUM PRACTICAL CAPACITY PER HOUR OF ROADWAYS UNDER TYPICAL CONDITIONS

	No Grade Crossings—No Stopping Permitted		City Boulevard with Grade Crossings—Parking Prohibited		City Street with Grade Crossings—Parking Permitted	
Roadway Width in one Direction	Number of Moving Lanes	Vehicles per Hour	Number of Moving Lanes	Vehicles per Hour	Number of Moving Lanes	Vehicles per Hour
20 ft	2	2,650 (a)	2	1,200	1	750
30 ft	3	3,550	3	1,800	2	1,450
40 ft	4	4,200	4	2,200	3	2,000

(a) New Jersey State Highway Department estimates 2,400 cars per hour under similar conditions on the elevated express highway of Route No. 25.

in capacity from stopping and parking along the curb. These capacities are shown above.

In the last two columns of the foregoing tabulation parking necessarily eliminates completely the use of one lane; it also, due to the interference of vehicles moving to and from the curb, reduces the capacity of the lane nearest the parked lane. Under the conditions of capacity volume and one-hour parking regulations, it is safe to estimate that cars moving to and from the curb will reduce by at least 20 per cent the normal capacity of the lane next adjacent.

We are now in position to measure the *passenger* capacity of these typical roadways; observations made in a number of cities indicate that use of automobiles in city travel result in an average loading per vehicle of approximately 1.7 passengers. Consequently, in calculating the travel capacity of roadways in cities for individual vehicles it is safe to assume that the loading per vehicle will vary little from that indicated by these observations which represent averages over a considerable period in many locations.

For purposes of comparison, the capacities of electrically-propelled travel facilities in cities are readily determinable. A single track on an ordinary major city street—assuming conventional street cars, approximately 48 ft. long seating 60 passengers—has a maximum capacity of about 180 cars per hour. Through congested areas in some cities a number greater than this is actually being moved over a single track, but to insure satisfactory speed a maximum capacity of 150 cars per hour will be assumed. Thus, a single track on the surface of a conventional street will move 9,000 *seated passengers per hour*—considerably more than the number of people traveling in automobiles on a *grade-separated, elevated highway* with four express lanes in one direction. Putting this in another way, the passenger capacity of a single track of conventional street cars, carrying only a *seated* load and running on a main business street subject to cross traffic interference, is more than twice the observed maximum through the present Holland Tunnel under the Hudson.

Furthermore, if two such tracks are located in the center of an ordinary 60-ft. roadway with parking prohibited, approximately 1,000 automobiles per hour may move through this street in each direction, thus making the capacity of such an ordinary 60-ft. city street, subject to cross traffic interference and with street cars carrying only a seated load, two and one-half times the passenger capacity of the Holland Tunnel. If we remove the street cars and turn over such a 60-ft. roadway exclusively to automobiles, continuing to exclude parking, it will require *in addition to the old street*, two and one-half new boulevards of the same width to move the same number of people.

In these comparisons, bear in mind that street cars are assumed to carry *seated loads only*, and highway lanes are assumed to carry the maximum number of automobiles that can move at approximately satisfactory speed.

The future use of electrically-propelled public transportation facilities in cities will be determined by the extent to which they can approximate automobile standards of comfort while retaining the substantial advantage of great economy in space requirements. It has therefore been assumed that in comparing the space requirements of an adequately developed public transportation system with a highway system for automobiles every passenger is an ideal standard of comfort.

When the growth of a city and consequent density of travel requires the construction of additional facilities above or below the present street surface, the community has the alternative of designing these facilities for collective travel in electrically-propelled vehicles on rails, or for individual travel in automobiles. It is important therefore to examine the relative carrying capacity of these two alternative forms of construction: Here, the community is called upon to provide new facilities for its circulatory system; under given conditions of travel density the number of new grade-separated arteries required, whether overhead or underground, will be determined by their passenger carrying capacity, established in turn by the decision as to whether they are to be equipped with roadways for automotive vehicles or with rails for electrically-propelled cars or trains.

One four-track subway, of 56-ft. excavated width and carrying two express and two local tracks like the New York subways has an ultimate capacity of 35 ten-car express trains per hour on a single express track and requires 30 six-car local trains on the adjoining track for intermediate station transfer travel. Assuming only a seated load per express train and corresponding conditions in local trains, such a four-track system will readily move approximately 47,000 people per hour in each direction. To permit these people to move by automobile, assuming that they could afford to do so, the community would have to provide approximately 10 elevated or underground highways of corresponding width. Here again, the capacity of electric trains is calculated on *a seated basis only*. It would require at least 20 tunnels or elevated highways of equal width to carry in automobiles the people actually transported at present standards of loading on one four-track line of subway in New York.

To solve the growing problem of traffic congestion in cities it seems hardly conceivable that the enormous economic advantage of collective transportation by electric power will not be utilized to a much greater degree in the future than at present. It is true that a much higher standard of convenience and comfort for collective transit facilities is necessary, but compared with community cost of rebuilding our cities for automobile travel, the economic advantage lies all with electric power in urban areas of high travel density.

May it be suggested therefore that the electrical engineer has a great opportunity and a great responsibility in the field of urban transportation—the birthplace of electric power. Not alone as engineers but as citizens of the community is it incumbent upon those in position to understand the intricacies of local transportation to aid in the adoption of sound civic policies. The future trend of development will be influenced by psychological and political factors as well as by economic and engineering considerations. The battle of power in transportation will continue to be waged not alone in the drafting room and laboratory, but in the arena of daily life where the public is the judge and where economic and engineering data may be outweighed by visionary schemes which appeal to the popular imagination.

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Industry Vs. Technical Education

Industry wants better men; educators want better support. Frank statements by leaders of both contingents are illuminating to young engineers and pave the way for co-ordinated attack upon a common problem.

INDUSTRY WANTS the technical schools to turn out men more soundly trained in the fundamentals of scientific and sociologic knowledge. Against this, the technical schools look to industry for more definite support and greater cooperation in the matter of certain specific educational problems.

Such are the impressions gained from expressions of nationally prominent leaders in industry and education as they presented their views and substantiations at a "Conference on the Relation Between the Industries and the Technical Schools," held at Lehigh University, Bethlehem, Pa., October 16, 1930, in connection with the dedication of the James Ward Packard Memorial Laboratory of Electrical and Mechanical Engineering. Excerpts from several of the speakers appear in the following paragraphs:

F. A. Merrick, president of the Westinghouse Company, undoubtedly sounded the keynote from the industrialist's standpoint when he said ". . . What the industry wants is men who can and will do some one thing better than it has ever been done before . . . who can add something to the sum of human experience, whether that experience has to do with design or manufacture, or research, or selling, or administration . . . and the technical man who is properly qualified and trained and willing to work has no limit to his possibilities in the (industrial) field.

"Industry expects a group of men so selected and so trained in fundamentals and in analysis, and in the application of such analysis to practical problems, that they can develop into the doers of everything needful for the solving of each problem in the whole range of requirements. It does not, however, expect men from the schools . . . to solve every problem concerned . . . much less all of them . . .

"The reasonable expectation of industry is satisfied if, for instance, Graduate A emerges with the capability of developing into the best there is in such-and-such a division of the field, while Graduate B is qualified and fitted for similar development in another perhaps equally important field; and Graduate C for still another field, and so on. The sum of A + B + C is what the educator is expected to furnish. . . . So the indicated procedures should aim to provide first of all a basic training that later would be usefully employed no matter in what class of organization the graduate might find himself . . . .

"The most frequently heard criticism of the technical man is that he is lacking in human understanding and in acquaintance with the world of affairs; and along with these deficiencies very often he is lacking in the exercise of adequate expression in speech or writing, especially on the subjects involving anything outside of purely technical subjects . . . .

"In confessing that there is considerable ground for this judgment it must be remembered that the ordinarily required preparation for a technical course makes great demands on the young man's time and energy. The same thing may be said of his pursuit of the subsequent technical career. All of this makes it doubly important that an early foundation in the so-called humanities studies should have due consideration in making selection among those applying for admission to the technical schools . . . . Post graduate work might in some cases—especially in research—be employed profitably in the schools, though as a broad proposition the real specialization comes only in the actual contact with the school of experience in the industry itself."

Alfred R. Glancy, president of the Oakland Motor Car Company, in echoing Mr. Merrick said in part: ". . . Industry is asking for men thoroughly trained in the fundamentals and with personality, . . . generous in tolerances, and humble; not with the humbleness of acquiescence, but the greater humbleness that is willing to take the suggestions of a better man and use them. . . . They should have disciplined spirits."

Mr. Glancy stated frankly that "engineering departments of many technical industries are carrying heavy quotas of foreign-born and foreign-trained men because these men with their practical foundations of scientific training are capable of great development. Also these . . . men do a more thorough job. They are happy with gradual advancement, which in turn makes for thoroughness of execution. Frequently, after two or three months on the drafting board or a similar time in the shop, our American graduates are discouraged because the glamorous executive positions about which they have heard so much are not immediately open to them."

In reporting upon a personal survey among motor-car manufacturing executives, Mr. Glancy stressed the undesirability of narrow specialization upon the parts of technical students, "for instance, in gas engine design." With equal emphasis, physics, chemistry, mathematics, English, political economy, economics and a "seasoning" of the purely cultural subjects were unqualifiedly recommended.

Matthew S. Sloan, president of the New York Edison Company, spoke with characteristic frankness representing the utilities view: ". . . We seek men who have attained good academic standing in their classes, but not necessarily the highest. We expect them to know their books and tables, but we expect them to know a good deal more; to know, for example, that books and classroom work are simply a foundation and that some of what they have been taught is already out of date or wrong. We expect them to know how to reason—how to think. We expect them to have curious minds, inquiring minds, eager to acquire information, active to associate it with other information, able to digest it and put it to use. We want them to have initiative and character. We want them to have intellectual and moral as well as physical courage. We want them to have a personality which will enable them to deal successfully with a trench digger or the presidents of the companies. We want them, having information and ideas, to be able to present them clearly and persuasively, orally or in writing.

"We want these men to have a technical education.—Yes, but a technical education which will help them in learning our business, and not one which will send them to us with a lot of theory which they will have to unlearn because it is behind the standards and practises of our business. I am speaking frankly. The practises of our business must always be in advance of what is taught in the classroom because it is impossible for the schools to keep abreast of practises in our industry where improvements are being worked out from day to day. We want technical graduates who have been taught how to learn, how to adapt themselves in the school of trial and work."

Bancroft Gherardi, vice-president and chief engineer of the American Telephone and Telegraph Company, and past-president of the Institute, also emphasized the importance of fundamentals: ". . . . What we want are men who can recognize the problems with which they are confronted, study the problems, determine the appropriate action, and then take such action in the right way. For men in the administrative and general engineering departments, these seem to me to be the essential requirements . . . Train the student to recognize the necessity of getting his facts; teach him the best methods of getting them, and train him to interpret engineering data and reason therefrom.

"One of my strongest convictions is that unusual effort may well be made to reach every engineering student to speak and to write a report or letter in clear, convincing English, setting forth the facts, arguments, and conclusions pertaining to the question before him. It is of the greatest importance to an engineer that he shall be able to state in correct and logical form the problem before him, and to enforce his conclusions with arguments which shall be convincing. Such training as this is not merely one in literature, composition, or rhetoric. To present such a report, the problem must

James Ward Packard Memorial Laboratory of electrical and mechanical engineering, Lehigh University, Bethlehem, Penna., where educational-industrial conference was held in connection with dedication ceremonies.

have been mastered and clear thinking must precede clear speaking or writing."

L. Warrington Baldwin, president of the Missouri Pacific Lines, likens the technical school itself unto a manufacturing establishment: ". . . The technical school today is essentially an industry. You may call it a foundry, melting and molding a material which we designate as a student mind into a crystallized and permanent thing we call a matured mind. You may call it a builder, shaping into a permanent structure of many parts the various things we call research and the application of the products thereof. You may call it the creation of an asset we call capital, a salable article or medium of exchange coined from the ore of natural and able mentality and offered for a circulating medium which, if the ore be good and the alloys strong, will not depreciate by usage . . . . .

"If the product of technical schools is to be a factor of increasing value to industry, it will have to insure in its operations the same progressiveness that characterizes industry. This is foremost in importance and cannot be overestimated . . .

"Great care must be used in outlining a course of study for young men looking toward the occupancy of executive positions. They should not be given the idea that a course of study alone will fit them for such positions any more than will a course in art insure that the student will become a great painter or a course in literature create a renowned author or historian . . .

"It should further be impressed upon the student that his diploma is not a magic wand which will open to him the door to success, but that after graduation and the securing of a 'job' and not a 'position' as a start, his progress is almost entirely dependent upon himself, except as it may be modified by fortune or misfortune."

EDUCATORS' POINTS OF VIEW

Paralleling the demands of the industrialists, the educators made some demands upon and suggestions to industry.

Arthur M. Greene, Dean of Engineering at Princeton University, commented upon the limited amount of time available to the technical school in which to educate its students saying, ". . . in this limited time only the fundamentals can be taught, and special details of a particular branch of industry should be given to its new employees by the industry itself, using that which the schools have done as a basis for this further training . . .

"Another thing which we should ask from industry is a constructive criticism of the work which we are doing as shown by our graduates . . . Could not industry in a fair, frank way inform us of any lack seen in our particular men? Of course, as engineers we should like both sides of the picture; and if our men appear to have a proper appreciation of these fundamentals and ability to grasp the new details which are presented, we should like to know of it so that we may carry on in this way which has produced these good results. Records and reports are to be used not only to eliminate faults but to maintain virtues . . .

Doctor Greene suggested that industry make more effort to carry on important researches in and with the cooperation of the laboratories of educational institutions so that students may benefit by contact with practical problems, industry may benefit by additional and independent points of view, and the school may benefit by having the use of special equipment installed by industry for its researches. Continuing he said, "At some of our technical schools cooperative research problems are being worked out by industry and the schools . . . The technical schools have the personnel, the equipment, and the space by which many problems of industry could be solved for those without research facilities; and for those with great facilities, these institutions are the natural places to which to turn for independent, original, or confirmatory work. The schools expect that industry will seriously consider this subject . . .

"The outstanding activity on a fairly large scale by industry, the summer conference for engineering professors by certain large manufacturing companies is one which the schools hope for from industry as a whole . . . Could not the smaller industrial plants offer summer employment to one or two men from the schools, even though a large conference is not possible? Each school has near it a number of industrial plants into which its teachers would fit.

"One of the requests which my own institution is making of industry is the summer employment of students, particularly for men who have completed the junior year. Many employers have granted our requests, and I now ask if this is not one which industry in general should expect from the schools. This would be for the purpose of giving the student a professional and commercial point of view to bring back to his college work, and at the same time to give the employer a chance to try out a possible employee for the next recruiting season."

D. C. Jackson, head of the Electrical Engineering Department of the Massachusetts Institute of Technology, pointed out that: ". . . Engineering schools expect industry to recognize the duty of the schools as educational institutions to maintain independence in thought, in subjects and methods of research, and in opinions. In return, the faculties should recognize a duty to refrain from spreading inadequately founded opinions and from dogmatizing in controversial fields . . .

"Engineering schools expect industry to recognize the importance of independent operative scientific research as part of the life of the faculties and students, and to support it with contributions of money and counsel made to those schools which are adequately manned and equipped, to the end that additional knowledge may be disclosed, out of which industry may forge new applications; and also, to recognize the importance of such research as a pedagogical instrument in those schools which are manned and equipped to carry it on properly.

"Engineering schools expect large industrial establishments in their own interest, to pay more attention to the assimilation of recent graduates into the industrial work for which they are employed. With few exceptions the present practise is to fit these new employees into places requiring very limited needs, and to make no provision for such employees to gain (except by chance) an understanding of the accomplishments expected of them, thus leaving them 'wallowing around' for months without light or leadership . . . Engineering schools expect that the personnel problem of employing young men who are on the eve of completing formal study in the schools will be dealt with by the employing agents of the industries in a judicious and discriminating manner . . .

"That the public may come to realize the propriety of industry making contributions of generous size to selected engineering schools for the support of independent research in those schools, engineering schools expect that industry will aid in laying before the public a fair statement of the public interest in continued industrial development and invention, and the need

Main floor, electrical end, Packard Laboratory. Mechanical equipment in the distant half and lighter apparatus conveniently placed around spacious balcony; careful planning facilitates maximum student use of equipment provided by a far-sighted industrialist of maintaining independent research in the engineering schools, in order that a stream of results may be available as raw material out of which to mould further industrial development and invention."

AN IMPORTANT SUGGESTION

One of the most far-reaching suggestions of the conference was voiced by David E. Ross, president of the board of trustees of Purdue University. Mr. Ross urged that: "it is not unreasonable for our higher schools to expect industry to help in the searching out of fine-grade human raw material with which technical education must work . . . If industry builds widely for its own future, adequate provision will be made whereby the brilliant mind-constructing teachers in the universities will have reward and remuneration commensurate to those granted productive industry. Technical education would gain immensely if a certain large proportion of the men who have attained recognized superiority in industry were permitted to return to the university to contribute, as only they can contribute, to the training of the new leaders in our material civilization."

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Australasia as Seen by an Engineer

South Pacific continent and its neighbor island present many features of interest; glimpses of a few are given here.

By Paul M. Lincoln

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FROM HONGKONG to Brisbane, Australia, is a three-weeks' journey—an indication of the magnificent distances which separate Australia from the rest of the world. The latitude of Brisbane in the southern hemisphere corresponds closely to that of southern Florida in the northern hemisphere, and January temperatures are about what one might expect of southern Florida in midsummer. General dryness of the air, however, makes the high temperature quite bearable.

As a northerner travels overland from Brisbane to Sydney, one of the noticeable things about the Australian landscape is the total absence of both the flora and fauna of our northern hemisphere. Practically every recognized plant or animal is an importation from the North. As is well known, some of the transplanted animals and plants have become well-nigh insufferable pests in the southern hemisphere. The rabbit, which to us in the North is probably the best known of these, has multiplied so rapidly in Australia that it has become a distinct menace to the grains and other plant life of that continent.

The cactus is another imported pest: particularly in Queensland has the cactus spread rapidly and occupied lands that otherwise would be available for grazing or cultivation. Its spread has caused much apprehension in Australia and recently a cactus pest was introduced which it is hoped will hold the cactus in check. Still another pest is the blackberry, which is particularly troublesome in New Zealand. Large areas of that country have already been overrun by the blackberry and as yet no adequate means of checking its spread has been found.

Sydney itself, a busy, bustling city of approximately a million inhabitants, has one of the finest harbors in the word—the finest, if one is willing to accept the Sydney citizen's own appraisal. However, since it has been found necessary to throw a bridge across it to the north at a high cost this harbor might in one sense be viewed as a handicap. Rapid growth of the city has made more usable territory desirable and the bridge connecting Sydney to the North Shore is now under construction; its completion is expected some time during 1931.

Another thing about Sydney that is reminiscent of New York City is the torn-up condition of the streets incident to the installation of a subway system. As in many another city, growth has made necessary a better transportation system, and again subways have been selected as the best available means of supplementing existing systems.

In the State of Victoria the development of greatest interest to the electrical engineer is the use of the brown coal at Yallourn, a district about 100 mi. east of Melbourne. This coal bed lies under an overburden of earth only about 30 ft. thick, a condition which permits open-cut workings with resulting nominal mining costs. At the present scene of mining operations the thickness of the coal layer is about 180 ft., but in some parts of the field, borings to the depth of 1000 ft. have shown several superposed beds of this coal having a total thickness of 808 ft. It is estimated that there is available for mining by the open-cut method at least 20,000 million tons. In the area of one square mile set aside for the initial workings, the existence of 150

Sydney Harbor Bridge (Australia), under construction to relieve traffic congestion, reminds one of the famous Hell Gate Bridge in New York.

million tons has been proved, a supply sufficient to serve a 150,000-kw. power station for one hundred years.

The moisture content of this fuel is unusually high, varying from 50 to 65 per cent, and naturally results in a low heat content as compared with the usual black coals. With a 60 per cent moisture content, the calorific value is about 4700 B. t. u. per lb. In spite of the low heat value the small cost of mining makes this fuel an economical source of power. The great problem has been to find the proper methods of burning it under boilers. The little experience that was available was in connection with the development of the brown coals of Germany, and it is only natural that much of the mining machinery used at Yallourn was designed and manufactured in Germany.

The major market for Yallourn power is Melbourne, 100 mi. away. However, some fifty or more other municipalities and townships in the State of Victoria are deriving their electrical power from Yallourn and its associated power stations. Eventually the system undoubtedly will cover a large portion of the State of Victoria.

At the present time, a small amount of water power is being developed and fed into the general transmitting and distributing system, and further water-power developments are contemplated for the future.

By most of us here in the United States New Zealand is considered as being a close neighbor of Australia; hence it is rather surprising to find that the run from Sydney to Auckland is nearly 1500 mi., or four days' sail, equal to nearly half the distance from New York to London. New Zealand differs from Australia in its abundance of water. Snow capped mountains reaching a height of more than 12,000 feet abound, particularly in the South Island. This rough terrain together with the abundance of water gives the country a decided preeminence in the matter of water-power. More than 80 per cent of the electrical energy used in New Zealand is developed by hydraulic plants. Of course in New Zealand as well as in Australia generation and distribution of electricity is carried on as a government enterprise.

New Zealand is divided into some 50 or 60 districts in each of which a "power board" (in every case a creature of the government) has complete authority in the matter of the generation and distribution of electricity. The extent to which the country has been electrified is astonishing; it is stated that at the present time 75 per cent of all possible users of electricity in New Zealand are being served, and that there is hope to increase this figure within a few years to 90 per cent. This really is remarkable when one considers that there are only about one and one-half million people in New Zealand with an area of 105,000 sq. mi. In other words, the average density of population is less than that of the state of Nebraska. In these electrical "undertakings" there is no endeavor to make a profit. Rates for service are so fixed that only cost of service will be met, including of course a sinking fund that eventually will cover the original first cost. This policy explains why New Zealand is able to serve so large a proportion of its sparse population; the fat districts carry the lean.

New Zealand and Australia are almost entirely pastoral; wool, mutton, beef and dairy products constitute by far the greatest proportion of all exports. As might be expected of countries so young and sparsely settled, very little manufacturing is done.

A thing that one cannot but note in both New Zealand and Australia is the strong sense of loyalty to the mother country. Other things being equal, the Australasian will buy his requirements from England or at least from some other part of the British Empire. In spite of this pronounced British preference, however, the prevalence of American automobiles is noticeable. According to personal observation at least 90 per cent of the automobiles in Australia and New Zealand are of American manufacture. To queries as to why this should be, answer was given that the American automobile suited Australian road conditions while the British did not. The Australasian was very frank to say, however, that if he could get a British machine that was suitable and right in price, the trade would go to Britain.

Automatic Operator Improves Efficiency

Because the burdensome detail of maintaining accurately predetermined loading schedules is more than present-day minimized operating forces can handle, seldom are hydroelectric generating stations operated at maximum efficiency when under manual control; automatic control equipment subject to manual regulation solves the problem.

By S. Logan Kerr

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GREATER EFFICIENCIES in hydroelectric plants must come from plant design and operation rather than from further refinements of design in the hydraulic equipment itself. The single important exception to this is to be found in the development of a new type of propeller turbine with automatically adjustable blades, the development and use of which is an important step toward bringing low-head plants to the relatively flat efficiency curve which hitherto has been found only in the medium- and high-head installations.

Operation studies of a number of plants show conclusively that the average operating efficiency rarely equals the maximum over-all efficiency of the station. In one of the newer large hydroelectric plants in the East, the over-all efficiency of the station was found from tests to be approximately 90 per cent, whereas detailed analyses showed that the maximum normally obtained in daily service was only about 80 per cent. The 10 per cent margin between these two figures was traced directly to inefficient loading of the plant and inefficient load distribution between the various units within the plant.

Other factors, such as the unnecessary lowering of the maximum operating head in the excessive drawing off of the small ponds and storage reservoirs, greatly impair over-all station efficiencies. Attention directed to these factors indicates a fruitful source of study for improvement in operating practise with recovery from losses to proportions hitherto unsuspected.

Hydroelectric stations of course must be operated with a definite understanding of the capacity of the station's available stream flow, the market for power, and the operating characteristics of the system to which its power is being supplied. For a plant in service, the general operating problems in so far as they are considered with respect to economy may be classified as follows:

1. Economic load distribution between units for any given station load and combination of generating units.
2. The economic output of the station corresponding to the points of maximum efficiency for the various combination of units.
3. The maintenance of the economic number of units or combination of units in service for any given load on the station.
4. The maintenance of maximum operating head and conservation of flow.
5. The control of pond levels with respect to flow when surplus water is available.
6. The maintenance of sufficient system reserve capacity to provide for system requirements, to be operated in parallel with the system and carried at a minimum cost. This may be divided into two types; reserve for immediate availability and reserve for delayed availability.
7. The maintenance of a fixed draft of water from storage reservoirs or through run-of-river plants, to supply the proper water balance on a given stream where more than one station is installed, in order to provide for plants farther down the river or to absorb the discharge from plants above the one under consideration.
8. Automatic frequency control to maintain constant frequency with the possible refinement of maintaining constant average frequency where electric timekeeping is a factor.
9. Automatic power-factor correction to improve line and distribution voltages and power factor within the limits of the machine capacities and by utilizing surplus machine from time to time as synchronous condensers.
10. The possibility of making use of flood water to increase the annual plant output.
11. The economy of spilling water over a fixed-crest dam under low-water conditions to secure full maximum operating head.
12. The possibility of increasing net plant output by decreasing the output of certain machines below the point of maximum individual efficiency.

The first five of these classifications deal principally with the hydraulic characteristics of the plant itself; Items 6 and 7 deal with the relation of the plant to system operation; and Nos. 8 and 9 may be classed as effecting the type of service rendered by the power company. The last three were suggested in a discussion presented by C. F. Merriam of the Pennsylvania Water & Power Company, Baltimore.

Most of these items have been given some attention by operating engineers but in most cases further attention could be given to advantage. Too much emphasis can not be laid upon the desirability of greater utilization of field-test results as a basis upon which to achieve better standards of operation and increased efficiency of utilization of the plant itself. Field tests can be made cheaply and simply in practically all plants by either the Allen or Gibson methods; and where these methods cannot be applied it usually is possible to employ current meters with a reasonable degree of accuracy provided sufficient care is used.

From "Automatic Operator for Economy Control," presented at the A. I. E. E. Middle Eastern District Meeting, Philadelphia, Oct. 13-15, 1930.

For purposes of determining the proper loading of the individual units, and the proper combination of units for maximum over-all efficiency for any given station output, accurate determination of unit-operating characteristics should be prepared along with schedules of economic load distribution between the units. In existing stations, a careful analysis of operating records taken from the daily log sheet will provide the bases for these determinations. For new plants, acceptance test data will serve; and where accurate test data are not available, it is possible that a combination of the manufacturer's test curves and the manufacturer's expected curves, combined with power-gage-opening tests on the actual installation, will provide sufficient information from which to prepare operating charts for units having similar characteristics.

For units with dissimilar characteristcs—which of course include units of different specific speeds and capacities, and occasionally units having the same capacities and speeds but built by different manufacturers—field efficiency tests are the only dependable source of information.

With the station and unit characteristics determined, an over-all schedule of operation may be prepared which will specify for each load on the station, the number of units required to carry the load, the proper combination of units, and the proper loading of each unit in order to maintain the best over-all efficieny. Based upon an estimated percentage of adherence to such a schedule, the question of load factor, load demand, and the rate of draw-down of the forebay, can be studied in their effects upon the maintenance of the maximum head. In cases where appreciable pondage or storage is available, a nice balance may be worked out between the permissible rate of draw-down during the demand hours and the building up of the head-water level at night. With low- and medium-head plants, particularly in a series development without head overlap between plants, it is of great importance in order to prevent loss in output and efficiency, to maintain the maximum possible operating head.

The factor of system reserve capacity also is one which should receive abundant attention and careful study to determine a reasonable margin of reserve to protect the system adequately against any shortage of power during sudden demand periods and at the same time to avoid excessive waste water arising from carrying too much reserve in parallel with the system. Because of the requirement of shutting down and starting up units at the proper time this phase of operation introduces still another burden upon the operating staff; also, because of the necessity for maintaining sufficient capacity in service to care for the normal operating emergencies which would cripple service if such reserve capacity were not immediately available, it introduces a serious responsibility upon the part of the system load dispatcher.

Studies of actual cost of carrying reserve capacity in any one plant, or with any combination of units can be made. On the same basis additional studies will indicate the desirability of operating units as synchronous condensers or merely as reserve capacity floating on the line. At most plants some saving can be realized by motoring the units from the line with the wheel gates tightly closed and the runner vented so that it operates in air rather than in water. The difference between the cost of maintaining the reserve by these two methods and that of having surplus units of light-load capacity represents a marked saving if the element of availability is assured.

It is self-evident of course that all of these factors have been given, and are being given, attention by operating engineers; the one element, however, which has hampered seriously the achievement of ideal economy in operation has been the necessity of depending entirely upon the human element. Further aggravating this same difficulty has been the tendency to reduce operating forces to a minimum, resulting in increased duties and responsibilities for the individual operators. Thus, the operator's attention has been forcibly directed to the prime requirement of maintaining continuous service, the question of economy necessarily becoming of secondary consideration.

The burden of maintaining accurate loading schedules, and of giving careful attention to each of the factors outlined at the beginning of this article, will pass beyond the realm of possibility for manual operation unless the present trend is reversed with a considerable increase in operating staffs and provision for rigid supervision. It is in this connection, because of the operating efficiencies that can be achieved with it, that automatic-control equipment has come recently into prominence.

With the development of automatic-control equipment the whole aspect of these operating problems changes, since the human element no longer becomes the limiting factor. Analysis of the economies of operation form the basis of preparation of ideal schedules adapted to the particular system requirements, and the application of specially designed automatic-control equipment permits the rigid enforcement of these ideal schedules, eliminating the losses which must result from the inability of operators to follow these schedules continuously.

One of the first applications of this principle of operation was made at the 87,000-hp. Norwood plant of the Carolina Power & Light Company, where the problem presented was to obtain the maximum operating efficiency out of two high-speed, large-capacity units with relatively steep efficiency curves, and one somewhat smaller slow-speed unit of a relatively flat efficiency curve. Design studies showed that with the units of different capacities a higher average efficiency could be realized for the plant over its entire range of output than would be possible if all three were of the same high-speed characteristics. Economic load schedules showing the proper distribution of load between the units necessary

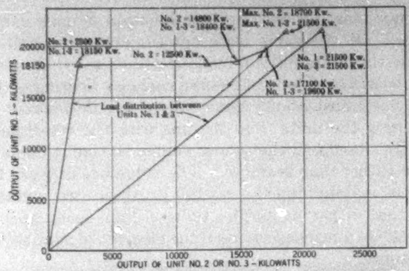

Fig. 1. Ideal loading schedule as calculated for the 87,000-hp. Norwood plant of the Carolina Power & Light Company

to maintain a maximum combined efficiency indicated a rather complex problem; at least from the standpoint of manual operation. It was demonstrated that slight departure from the proper loading schedule would result in appreciable loss in efficiency.

At Norwood the equipment as actually installed consists principally of a multiple bridge circuit, one side of each bridge being a manually-adjusted standard potential and the other side a potential in proportion to the unit output. By basing the standard potential relations upon the ideal schedule for load division between units, the balance would be secured at a point at which the load on the various individual units would be brought to the standard as manually set; this in turn agreeing with the desired load distribution between units. A single dial, subject to the control of the operator, accomplishes an economic load distribution between any combination of units in service. Additional attachments make for more flexible operation but introduce no change in the basic principle involved.

Study of the curves in Figs. 1 and 2 will reveal what application of automatic control can accomplish to relieve plant operators of the burdensome routine; also what can be accomplished by maintaining the highest possible operating efficiencies at the station. The circles show the results of manual operation while the triangles represent the operation with the automatic control in service. In Fig. 2 the upper envelope curve represents the maximum over-all efficiency of the plant and it is of some interest to note how accurately the automatic operator follows it as indicated by the close proximity of the triangle. The approximate figures indicate that in so far as its relation to the ideal operating curve is concerned, on manual control the production efficiency of this station was approximately 90 per cent. With the automatic operator the average operating efficiency has been raised to a point in excess of 96 per cent and has been kept as high as 98 per cent for appreciable periods of time. The difference between the ideal operation represented along the upper envelope curve of Fig. 2, and the actual results secured at the station, include all losses due to the incorrect number of units in service, as well as the losses introduced by maintaining system reserve capacity. The actual loss incurred by incorrect distribution of the load between the units while under automatic control has been materially less than 1 per cent.

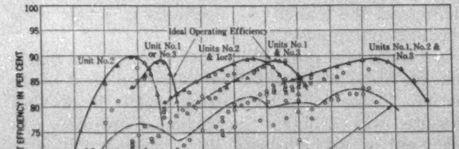

Fig. 2. Over-all plant efficiency curves for Norwood plant

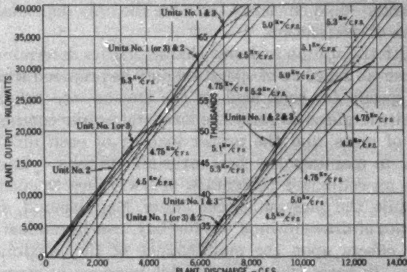

Fig. 3. These curves, showing power output with respect to water discharge, simplify the work of the load dispatcher

At the Norwood station daily efficiency log sheets are carefully kept to furnish the basis of detailed analyses through which the operating engineers may determine the reasons for production losses—accurate records upon which to base their efforts, and by which to direct attention to the elimination of losses.

To simplify the work of the load dispatcher, the curve sheet reproduced in Fig. 3 was prepared representing the station output with respect to station discharge and with superimposed radial lines representing uniform increments of the kilowatts obtainable for each sec-ft. of water passing through the station under the rated head at which the plant normally operates. These radial lines intersect the power-discharge curves at various points, and both the load dispatchers and station operators can see at a glance the zones of desirable operation.

By means of these curves and log sheets, combined with the assurance that whatever load is dispatched to the Norwood station will be carried in the most economic manner possible, the system operators and load dispatchers were provided with a more efficient tool with which to work. This resulted in operating efficiencies and reflected exceptionally large savings to the power company over and above the very best possible with manual operation.

Another interesting application of automatic operator equipment was made more recently at the Morony plant of The Montana Power Company, near Great Falls, Mont. Morony was designed to effect system control and automatic frequency control equipment was installed as part of the hydraulic turbine contract. Both units in that station are of the same size and operating characteristics, and it was estimated that the requirements for maintaining frequency on the Montana system would call for the continuous operation of both units through a range of output from one-half to three-quarters of their full-load rating. As the load on that system is subject to variations not easily predicted, question arose as to the loss of efficiency emanating from the operation of two units at less than one-half of their individual capacities where the load could be more efficiently carried on a single unit.

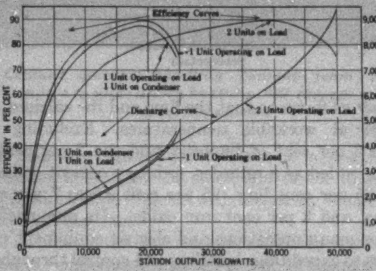

Fig. 4. Performance of the Morony plant of The Montana Power Company under control of an automatic operator

With the application of automatic frequency control to Morony, a further step was made in the development of automatic economy control by arranging special equipment automatically transferring one unit from operating on load to operation as a synchronous condenser, where the point had been reached of one unit alone carrying the particular load demand of the station more efficiently than could the two units together. From Fig. 4 it may be seen that for an output of less than about 23,000 kw. it is more efficient to run a single unit than to operate both units. Under this condition it was impracticable to shut down one of the units because it was necessary from a system standpoint that the surplus power of the two units be immediately available to care for sudden load demands. This requirement led to the development whereby one unit when its generating capacity is not needed is transferred automatically to synchronous condenser operation. By the use of efficient automatic air vents, the power required to drive one unit as a synchronous condenser is held to very small limits, as shown by actual tests and as reflected by the curves of Fig. 4. Provision was made also to return this reserve unit automatically to load service whenever it was required, this to be done either at a very slow rate for normal service, or at a very rapid rate for emergency conditions.

Fig. 5 represents the economic analyses of Morony station with the saving effected by the automatic control plotted with respect to station output. By the operation of one unit as a condenser and one unit on load, based upon the utilization of the same water flow as would be required for two units carrying this same load approximately 24,000 kw. in capacity are saved. According to the latest studies this represents slightly more than $7 per hour saving (3 mills per kw. hr.) for each hour that the plant is operated at an output of less than 18,000 kw. Since storage facilities are available, these same savings can be translated into savings in discharge as shown.

The possibilities of extending this type of control to other applications is at present virtually unlimited. The same principles that have been outlined in connection with the application of automatic economy control to individual plants are readily adaptable to the operation of groups of plants, including a combination of steam-electric and hydroelectric plants.

Application of automatic economy control to electric power generation requires an intimate knowledge of system characteristics as well as prime mover characteristics. The success of automatic economy control installation can reach its highest degree only through complete cooperation between the manufacturer and the operating company and by maintaining an impartial attitude in regard to the equipment to be used, its application and its limits. To secure the ultimate aim of the highest efficiency of power generation possible with the installed equipment the engineering of design and application must be carried on with these principles in view.

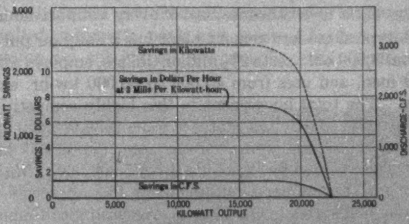

Fig. 5. Automatic operation at Morony translated into savings

Electricity in the Cement Industry

By R. H. Rogers

General Electric Company
Schenectady

Electric shovel in cement mill quarry

Practically completely electrified, the cement producing industry uses 2½ billion kilowatt-hours of electric energy annually in the production of its $275,000,000 output of 175 million barrels.

AN INDUSTRY which uses 2½ billion kilowatt-hours of electric energy per year at practically unity power factor, and at the highest load factor known to the larger industries, presents many interesting features to the electrical energy. In the Portland cement industry the use of electric power in new plants is becoming universal. The greater part of it is purchased power and all of it is used subject to extraordinary efforts to get the most out of every kilowatt-hour.

A typical modern cement plant has a daily output of about 3,000 bbl., costs 2½ million dollars, employs some 200 men, and uses from 45,000 to 60,000 kw-hr. each day. The total investment in this highly competitive industry in the United States is some $650,000,000 and the value of its annual output of 175,000,000 bbl. (700,000 94-lb. sacks) amounts to $275,000,000. Major plants of this industry, totaling some 160, are scattered through 33 states in the Union. According to Cement Association estimates, 33 per cent of the annual manufactured product is used for road construction, 25 per cent for building, 15 per cent for rural uses, and the remaining 27 per cent is scattered over some five classifications, the last of which covers bridges, river and harbor works, dams and water power projects, and takes only 4 per cent.

Commercial Portland cement is more or less a varied mixture of tricalcic silicate, dicalcic silicate, tricalcic aluminate and tricalcic ferrite. The alumina and iron oxide act as fluxes so that the lime and the calcium can combine at workable temperatures. Excluding the normal 5 per cent of impurity and the 2 per cent of gypsum added as a retarder, ordinary cement contains about 65 per cent lime, 25 per cent silica, 7 per cent alumina, and 3 per cent iron oxide. Its manufacture involves many operations and electric equipment contributes to expeditious handling and control throughout the processes.

In a typical installation raw materials are taken from the quarry by electric shovels, hauled by electric trains to electrically-driven crushing plants whence the materials go through various grinding, handling, and mixing processes, all electrically controlled. Slurry, the output of the wet process tube mill, is pumped to storage basins and correcting tanks where a chemist maintains the working stock at the desired chemical status.

Gigantic tubular revolving kilns, some as large as 12 ft. in diameter, 350 ft. long, and weighing more than 400 tons—by far the largest moving pieces of machinery in the world—receive the slurry for heat treatment. To stimulate a natural flow of its contents, the kiln is inclined at a pitch of approximately ¾ in. per ft. and to keep its contents duly agitated it is revolved at speeds varying from one-half to one rev. per min. About

Adjustable-speed, 75/100-hp., 230-volt, d-c. motor driving kiln through 900:1 reduction gear

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Presented at the A. I. E. E. Southern District Meeting, Louisville, Ky., Nov. 19-22, 1930. Full text printed herewith.

Cement pumps handling cement from dry grinders to silos; driven by 60-hp. 900-rev. per min. induction motors

three hours are required for the material to pass through the longer kilns from the stack end to the firing end, during which time it meets with increasing temperature up to 2,900 deg. fahr.

In its passage through the kiln, the slurry is gradually raised in temperature through a zone of chemical reactions to a point of fusion, the product of which is clinker about the size of ordinary marbles. This white hot clinker then passes through long cooling drums to storage where it may be kept indefinitely—even outdoors since it is impervious to moisture. It is hard enough to scratch glass, dark brown or black in color, and bears no physical resemblance whatever to either its raw material ancestors or to the Portland cement which it will be when finely ground.

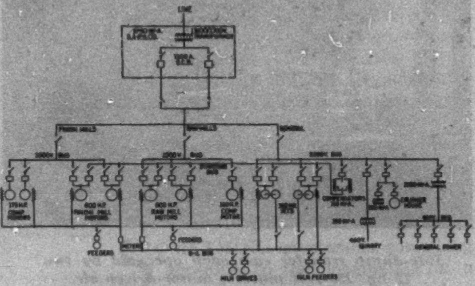
From the pulverizing tube mill the highly chemically active grey powder—Portland cement—is pumped electrically to storage silos from which it is reclaimed for shipment.

From the central station load standpoint, the cement mill is attractive because it runs through the 24-hour day, often operating as much as two years without shutdown. A plant having a capacity of 3,600 bbl. per day will have a connected load of about 6,500 hp., and the small percentage of idle equipment means a load factor exceeded by few, if any, other industrial loads. Further, the commonly used synchronous motors facilitate power-factor control, adding to the attractiveness of the load. In spite of the fact that waste heat available from the kilns is sufficient to operate a power station of ample size to serve the mill, power usually is purchased. Although many waste heat plants are in operation, advantageous power contracts available in recent years, together with a desire on the part of the cement companies to devote all available capital to the production of cement, have tended to suppress the tendency to install waste-heat boilers and turbine-generating plants.

In cement mills at least three common arrangements of electric power distribution are in vogue: (1) A 2,300-volt secondary system with small 2,300/440-volt transformers scattered about the plant at convenient low-voltage centers; (2) separate transformers with 2,300- and 440-volt secondaries placed at the substation; (3) transformers with secondary windings for 2,300 and 440 volts.

The present tendency is to concentrate all circuits at the main switchboard and to control all of the larger motors throughout the plant from that point. Rigid demand specifications common in power contracts make desirable the avoidance of peaks and this is done in some instances by having all heavy motor starting executed by the switchboard attendant, upon signal from the machine operator. This enables the switchboard attendant to watch his demand meter for an opportune moment, a practise which permits full-voltage starting on even the largest synchronous motors, thus simplifying the control and reducing control investment.

On the main switchboard, some newer mills have installed automatic peak and demand limiters which function by cutting off temporarily certain preferred



Circuit lay-out used in one prominent 3,600-bbl. mill; arrangements vary widely in different mills

Battery of 4-in. slurry pumps driven by 30-hp., 1,500-rev. per min., 440-volt, 25-cycle motors loads when peaks threaten, as well as cutting off larger banks of motors when the 15-min. demand limit is threatened. Air compressors used in a mill may involve as many as four 175-hp. synchronous motors, and solenoid-operated unloading valves are used often to alleviate impending peak conditions for short periods of time.

Another refinement successful in automatically holding the plant power factor at unity is accomplished by arranging the power factor meter to control the field strength on an excitation motor-generator. With a falling power factor this arrangement permits the generator field to be strengthened and the resulting increased excitation on the synchronous motors driving the tube mills tends to restore the desired power factor.

Side-dump transfer cars each operated by two 75-hp. 250-volt motors; motor-driven air compressor on each car

Diverse characteristics of the motor loads in the cement mill make necessary the use of many different types of motors, including adjustable-speed, d-c., wound-rotor induction, squirrel-cage induction, and synchronous motors. For kiln drive and for various types of material feeders requiring a wide range of adjustable speeds, 230-volt, d-c. motors are used. Feeder motors most commonly are 5-hp. open-type units, while kiln motors may be rated at from 50 to 100 hp. Controls for the various motors are concentrated in groups at convenient points so that the kiln operator may control the slurry or dry feed, the coal feed, the kiln rotation, and other related operations.

Electric power shovels are meeting with much favor in cement mill quarries, and those subject to heavy work are almost sure to be operated on generator voltage (Ward Leonard) control. On such shovels there is a motor-generator set, either synchronous or induction, with three d-c. generators, one each for the hoist motor, the swing motor, and the "crowd" motor. Operation and reversals of these motors are controlled solely by the strength and polarity of the fields of their generators, a system which enables the shovel to do a tremendous amount of work in such a smooth way that maintenance no longer is a heavy item in shovel operation. On some properties electric traction is used, and of course d-c. motors carry the burden. Self-propelled side-dump cars, each hauling a trailer, are used at one prominent plant.

Wound-rotor induction motors are used on heavy duty equipment, such as quarry slope hoists, rock crushers, hammer mills and similar equipment, where the current inrush to a squirrel-cage motor would be too great for full voltage starting or where graduated acceleration is desired. These motors are used also for adjustable varying-speed service, such as required for kiln drives, by using constant duty resistors in the secondary circuit. Large motors of this type are operated from the 2,300-volt circuit, while the small ones operate on 440 volts. Squirrel-cage motors of two types are used, but the normal single squirrel-cage type greatly predominates.

In the modern cement mill synchronous motors account for the greater part of the power applied. Normal-starting-torque synchronous motors are used on the d-c. motor-generator sets, air compressors and similar equipment. Tube mills—huge revolving cylinders, in the larger sizes each containing perhaps 100 tons of hard steel balls or grinding pellets in addition to its load of clinker—require from 400 to 900 hp. to drive them at 20 rev. per min. These mills offer a starting load often as high as 160 tons, representing a motor load of from 125 to 180 per cent of normal.

"Super-synchronous" motors provide for full-load starting; the four 800-hp., 180-rev. per min., 2,200-volt motors drive two mills for finish grinding

For this particular duty "super-synchronous" motors were developed. This type has a stator mounted on trunnion bearings and surrounded by a band brake. When it is desired to start one of these excessively heavy loads, the brake is released and the stator brought up to synchronous speed while the rotor and its load are standing still. This makes available the whole normal pull-out torque of the motor for starting the tube mill load and, as the brake is applied gradually, the stator slows down and the rotor speeds up. Of course, the sum of the stator and the rotor speeds always is synchronous speed. After from 10 to 20 sec., as dictated by permissible current limits, the stator is brought completely to rest and the motor thereafter continues to perform as a normal synchronous unit. The brake may be applied either by hand or by a direct-connected pilot motor set to operate at a predetermined rate. In common with the other synchronous motors the power factor of these machines may be adjusted to suit the power factor demand of the plant. Normally, these large motors are started from a reduced voltage bus energized through an auto-transformer or compensator, although in some of the new mills they are started direct on full voltage.

High torque synchronous motors are being applied with good results to tube mills where the power system is adequate to stand the current inrush incident to eight- or ten-second starting. The motors have double squirrel-cage or amortisseur windings, which affect the starting torque and starting current just as the same construction affects a squirrel-cage induction motor. This type of motor presents the simplest form of synchronous motor drive for hard-starting loads, since it requires no clutch or special mechanical construction.

In a 3,600-bbl.-per-day cement mill of modern design there will be about 3,000 hp. in induction motors and 3,500 in synchronous motors. Power factor of the induction motor division will range from 0.82 to 0.85, since all of the motors are fairly high-speed units and carry practically full load, while synchronous motor power factors, of course, are controllable. A common practise in one mill is to operate all of the smaller synchronous motors at unity power factor and to operate four 600-hp. units at 0.90 leading. This results in 3,009 hp. operating at 0.82 lagging power factor, 1,000 hp. at unity power factor, and 2,400 hp. at 0.90 leading power factor.

Continuous operation is of vital importance in several of the steps in the manufacture of Portland cement, and extraordinary precautions are taken to avoid shutdowns. Duplicate units, high class wiring, ample sizes for all equipment, high class supervision and careful maintenance make possible continuous runs of as long as 23 months. After such a period drastic renewals and other maintenance measures are executed to make possible another long and uninterrupted period of production.

Safety to personnel is provided for in the cement industry to a degree not found in many other industries. This attitude is reflected in the entire electrical installation accounting for the prevalance of push-button magnetic control for the mechanical safe-guarding of live parts of motors and control and for the strict enforcement of rules limiting changes or adjustments to electrical equipment to properly qualified persons.

A few years ago cement mills were considered to be particularly hard on electric motors and similar equipment because of the prevalence of abrasive dust. Corrective measures have been so extensive and successful, however, that no extra precautions now are needed to insure successful operation of electrical devices in a cement mill. In fact, motor generators, air compressor motors, large mill motors, and in some cases even the switchboards themselves are installed out in the open in the mill room, a place where in the older mills the dust was the thickest. Today, a cement mill may be made as clean as a food producing plant.

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What of the Foreign Job?

In the new and rapidly developing countries lie great opportunities for speedy advancement, so attractive to the young engineer; but forethought is necessary if such a step is to be taken advantageously.

By Percy H. Thomas

Consulting Engineer, New York
Fellow, A. I. E. E.

SOMETHING mysterious, something appealing to the imagination of a young engineer, is to be found in the contemplation of a "foreign job." The idea of going abroad among a group of people perhaps somewhat backward in latest engineering and construction methods, and helping them to create a record-breaking mining plant that will earn large profits; or, to install a far-spread and efficient power system to bring from high mountains electric current for a great city with incidentally a large financial nest egg,—is enough to stir the blood of any young, ambitious engineer. This after all is as it should be.

When, however, a young man with a few years' experience in practical engineering, asks for advice as to whether to seek a job abroad or to stay at home, the impulse is to recommend that he stay at home. For this there are good sound reasons; the chief one, that experience has proved that the goal pictured by the imagination of the young man is seldom achieved. Conditions involved in scoring a conspicuous success in foreign engineering fields are many and exacting, and few men have the requisite qualifications. Not many, however, realize their own limitations, nor the difficulty of maintaining a proper perspective in new surroundings. Once a man is launched in a foreign country on a three-year contract a change of berth is no longer easy. Nevertheless, for the right man this service abroad offers inviting opportunities.

There are two types of service to be considered. In the case of the man from "the States" the simpler and more usual undertaking is the signing of a contract with a large construction or operating company, controlled from the home country—a job somewhere in Mexico or South America. In such a case, the man goes among people of his own kind—speaking the same language, with the same background, and living the same sort of life. All matters of transportation, housing, sanitation and health, and the regularity of pay day are company provisions. The real effect of the situation, however, is to give opportunity for intensive technical work, free from distraction and with a good chance to use ingenuity and resourcefulness in overcoming new or locally adverse conditions. There is a chance to evidence intelligence, grit, and character; and two or three years in a foreign country under usual conditions will go far to develop all these qualifications. It is remarkable how one's personal characteristics are stressed; always liquor temptations must be met, and when abetted by example, homesickness, and physical exhaustion it becomes insidious and hard to resist. The success and promise of many a young man has been destroyed by overindulgence.

Also, away from the society of women acquaintances, it is difficult to satisfy a longing for society. On the foreign job women are few and most of those present are married. With the persons assigned to work with him a man often finds himself thrown with unpleasant and uncongenial personalities; this will be trying and frequently irremediable.

Conditions are usually even more difficult for a man who takes his wife with him, for the limitations of such a life weigh more heavily upon her. Lack of conveniences, absence of the relaxations and diversions to which she is accustomed, and the long distance from relatives and friends, are trying, especially since the woman does not have the stimulus of the job's constructive work. And discontented wives may cause real difficulty. But there is another side to the woman's work on the foreign job; a tactful, good-willed woman can do wonders in brightening up camp life and in organizing social activities. In fact companies depend upon a sufficient proportion of this type to keep the spirits of their men normal.

On a foreign job, advancement in authority and personal development are rapid, and a man may rise far in three years. Ability and adaptability count; and further, a man usually gets a wide variety of experience.

At the end of the first contract, the difficult question arises whether to stay or return home? In the latter case there is usually little difficulty in picking up the home threads, the period of absence not having been great. But for the successful man, with offer of more pay, more responsibility, more interesting work, and a feeling of partnership and loyalty for the enterprise, the temptation to stay is strong. Generally, if a man takes his second contract he has crossed his Rubicon and is likely to have a more or less permanent stay. But if he wishes to marry, the question of finding a wife is a formidable one; some find girls of their own nationality on the job; some marry women of the adopted country, but ordinarily, the choosing is under unfavorable auspices.

When the family begins to grow up, the question of schools increases the difficulty, and usually as they reach their late "teens," the young folks are sent back to the home country. The sequel is that when they arrive at college age or even later, there is effort for the return of the whole family. Then the engineer finds himself out of touch with home conditions and former friends. Very few succeed in placing themselves to advantage, some obtain only inferior positions, and not infrequently, a man with financial obligations must return if he may, to the old job.

It is sometimes supposed that companies pay exceptionally high salaries to engineers going to foreign jobs; this is a mistake, for salaries are likely to be rather less than more. It may be said, however, that on the foreign job it is comparatively easy to save a large part of the salary, and this, in the course of years, may amount to a material sum.

The second type of foreign service is the engineer who goes to stay in the new country; to develop with its life and industry. Only those exceptionally fitted and very sure of their ground should consider this course. At the start it is difficult to picture clearly the process and outcome, but once the die is cast it will be hard to turn back, even though many periods of doubt and regret may arise.

Success will lie in entering whole-heartedly into the life of the country and adopting its ways and ideas; not on sufferance, but with approval and appreciation. In civilization, point of view, mode of living, use of leisure, and so on, the people of a foreign country are apt to contrast strongly and unfavorably with those at home. It should not be forgotten, however, that their customs may be different rather than inferior; that life and happiness are complex, and that after all only a few of the opportunities of pleasure and culture offered anywhere may be embraced. While one life may excel in certain things, another may lead in others. Genuine success must be based upon accomplishment, friendships, and appreciation of one's neighbors. Human nature is the same the world over and it is a fact that if one treats people kindly, appreciating their good points, assisting in their enterprises, training oneself in their language, studying their literature, and being generally sympathetic, the reward will be ample.

It is the new and rapidly developing countries wherein lie the coming generation's opportunity for service and advancement. Splendid possibilities for competent individuals as representatives of home companies exist in foreign countries, but to hold the confidence and sympathy of the native men of affairs and at the same time serve the best interests of the home company is no mean achievement.

Small Alternators now Fully Automatic

By Earle R. Wetzel

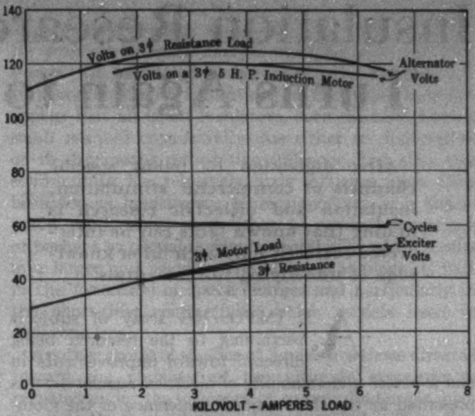
Electrical Engineer, Kohler Co., Kohler, Wis.
Associate A. I. E. E.

FULL-AUTOMATIC alternators with inherent voltage regulation are now available in 5- and 10-kv-a. sizes. These units have been designed especially to be used in connection with small engine-generator plants where an a-c. supply is desirable. With this equipment a distribution system may be of standard two- or three-wire construction in which every switch operates as a remote-control device for operating the plant without special control circuits.

In the design of this machine difficulties formerly met in connection with inherent regulation have been overcome. Armatures for both alternator and exciter are mounted on a common shaft carried on a single set of bearings. Further to simplify construction the two sets of field poles are mounted in a single frame. The resulting combination machine has a voltage regulation nearly the equivalent of a compound-wound d-c. generator, and achieves this end without manual or sensitive automatic devices.

The two armature cores are built from standard laminations and assembled on a common shaft with slots in approximate alinement. Each exciter armature coil is form-wound with a definite number of long and short turns with a continuous conductor. Short turns are lap-wound in the usual way in the exciter slots only, while the extensions constituting the long turns are laid simultaneously in the alternator slots. Alternator slots are only partially filled with the long coils from the exciter armature and in these slots, the alternator coils are assembled subsequently in any voltage or phase relation desired. The two sets of windings are insulated from each other, and therefore the two voltages are independent.

In operation with zero current output from the alternator, the exciter voltage is the vector sum of that generated by the exciter windings revolving under two sets of field poles. Each alternator field pole is opposite in polarity to its adjacent exciter field pole and displaced approximately 40 electrical degrees in the direction of rotation. There is therefore a differential action of the generated voltage in the extended exciter armature coils as compared to that portion in the exciter armature slots. Any weakening of the alternator field reduces this differential voltage, permitting the exciter voltage to rise somewhat proportionately.



Voltage curves of three-phase alternator-exciter unit for various loadings. All curves at running temperatures and with increasing loads; voltage of cold plant about 130

Double armature assembly of 5- and 10-kv-a. full-automatic alternators

It should be realized that any alternating current in the alternator coils is in synchronism with the respective field magnetism in such a way that the extended exciter armature coils receive their magnetic flux resultant from that of the alternator field poles and the ampere-turns of the alternator coils in the same slots. This change in the relation of voltages generated in the two sections of each exciter armature coil gives the effective compounding desired, and the angular relation of the two sets of field poles decreases this differential or bucking action on low power factors with a corresponding rise in exciter voltage.

To maintain stable exciter voltage over a wide range of alternator loads without extreme magnetic saturation on the heavier loads, the exciter voltage increases approximately 50 per cent on full alternator loads, with a possible 100 per cent rise when starting large polyphase motors. Effective compounding can be altered, if necessary, with an adjustable resistance in the alternator field circuit.

While this system of voltage regulation may serve only small alternators of low voltage, it is machines of this capacity which do not receive technical attention in service. Full-automatic operation necessitates automatic voltage control.

Insulation Research Turns Again to Fundamentals

After digression to follow specific channels of commercial stimulation, insulation and dielectric research is finding that known facts can be interpreted correctly only with fuller knowledge of underlying fundamentals.

AN IMPOSING array of subjects pertaining to the research being directed toward improvements in and a better understanding of electrical insulation was presented at the third annual conference of the Committee on Electrical Insulation of the Division of Engineering and Industrial Research of the National Research Council. This conference was held at the Bureau of Standards in Washington, D. C., Nov. 7-8, 1930, and attracted the attendance of more than a hundred physicists, chemists, and electrical engineers.

It was of particular significance to note that the trend of research effort in this field is definitely toward a better understanding of fundamentals. This gives rise to hope that the proponents of the three widely held and largely incompatible theories—(1) dipolar molecules, (2) anomalous conduction, (3) colloidal assemblages—may find common ground for an understanding. At the present time none of the theories held really satisfactorily explain the insulation problems faced by the practical electrical engineer.

In an attempt to present something of a cross-section of the activities reflected at the Washington conference the annual report of Doctor J. B. Whitehead, its chairman, is presented herewith practically in full and abstracts of reports of several of the specific studies are presented on the following pages.

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Year's Efforts Show Commendable Progress

By Dr. John B. Whitehead

The John Hopkins University, Baltimore
Fellow, A. I. E. E.

RESEARCH and development in the field of dielectrics and insulation have resulted in notable progress during the past year. Experimental studies have ranged from fundamental questions in the fields of pure physics and chemistry, through the important intermediate field of effort made to bring together the talents, resources, and enterprise of both pure and applied science to the wide and always active field of direct development by cut-and-try methods for the improvement of insulating materials and structures.

LIQUIDS

In the class of fundamental studies those of perhaps most direct interest are the studies of dielectric constant in liquids, with particular reference to molecular orientation and the contribution of this phenomenon to the resulting polarization. Of special interest is the increasing discussion of polar molecular orientation as an explanation of dielectric loss under alternating stress. Another important group of studies is on the relation between fundamental chemical structure as varied through a series of liquid isomers and their corresponding electric and other physical properties. Several independent researches of this type now are under way. Interest in these two groups of problems is general, not only in this country, but also abroad. More than any others, they give promise of further knowledge of the ultimate structure of the dielectric molecule. Closely related studies are those on the conductivity encountered in commercial insulating liquids and its relation to alternating stress. These liquids often excel in electrical properties, the purest used in physical research and obey much the same laws. In these cases the laws of conductivity are found to vary widely as related to both electric stress and duration of application, both having immediate bearing upon the amount of loss under alternating stress. Several theories have been proposed as to the origin and nature of the several types of ionic carriers apparently present in these phenomena.

CRYSTALS

Important fundamental studies are being directed also to the problems of solids as exemplified in crystals. Their relative freedom from impurities gives favorable opportunity for study of the nature of their residual conductivities, polarization electromotive forces, ultimate electric breakdown strength, and other allied properties. One result of this work has been to show that the structure of even the purest crystals of any considerable size is not so uniform as supposed, and that irregularities and faults often play an important part in the electric behavior of even the best of these materials.

BREAK-DOWN STUDIES

In the intermediate class of studies in which effort is made to combine fundamental knowledge and technique with the problems of practise, there is a remarkably wide range of studies on the breakdown strength of gases, liquids, and solids. Development of the cathode ray oscillograph has extended the range of the intimate observation of short-time phenomena enormously. As a result, in the case of gaseous breakdown, early apparent discrepancies between the results of observation and the indications of Townsend's theory of secondary ionization are now through the recognition of other influences in a fair way of being removed. Chief among these is new evidence as to the importance of space charge resulting from the initial stages of ionization, in setting up new and higher values of local electric stress. The importance of these phenomena in their relation to the shape of discharge electrodes has been recognized with resulting indications for improvement in the breakdown strength of the various flashover gaps of practise.

There have been several series of careful investigations of the conditions surrounding the breakdown of liquids ranging from those of simple type such as hexane, pentane, and xylol, to transformer oil and other commercial insulating liquids. These studies present much new evidence on the influence of temperature, pressure, and shape of electrodes, and particularly of the conductivity as a measure of the dissolved impurities. There is recent evidence that a variation of breakdown voltage with pressure may be entirely attributed to impurities.

Many studies on the breakdown of solids have been reported, mostly from German sources but with one interesting group in this country. Efforts in all this work are directed largely toward a closer control of temperature and field distribution. Results always point to a separation of several possible types of breakdown, notably the simple electric breakdown as based upon molecular structure, and thermal breakdown resulting from temperature increase of conduction in its influence as ionizing agent or directly on molecular breakdown through increased kinetic activity.

CONDUCTIVITY OF INSULATING LIQUIDS

Other studies in the intermediate group referred to are those of the conductivity of insulating liquids with special reference to the modification of their properties through mixtures. An example is an interesting proposal which traces the residual conductivity always found in insulating oils to the presence of colloidal particles always present in such oil. These particles have high powers of absorption which converts them into large, heavy ions. Their action jointly with ions of other types may be invoked for explaining several well-known, but hitherto little understood, peculiarities of liquids of this class. Supporting the suggestions of several speculative studies in this field, the presence of space charges in liquids also has been shown with associated variations of potential gradient. In accordance with indications of this type, it would appear that all liquid insulators, even the best, have a small residual conductivity due either to dissociation or to extraneous radioactive influence, but that this conductivity has relatively little influence upon their behavior as insulators. More important is a superposed conductivity due either to residual impurities or perhaps to partial molecular instability, which results in a larger and heavier type of ion that plays its part in the formation of space charges and particularly in the short-time conductivity which reflects itself in dielectric loss.

Another group of studies of liquids are those directed toward the stability of the ultimate structure as revealed under the influence of corona discharges, high stress, cathode ray bombardment, and the like. The gases involved and the residual products are looked to for indications of the nature of the deterioration process in insulating oils.

HIGH-TENSION LINES AND CABLES

Also covering an extension range, the third broad group of development studies involves direct experiments on the improvement of known insulating materials and methods, and the discovery of new ones. Improvement of insulation for overhead high-voltage lines heretofore has not engaged the attention of the National Research Council's committee on electrical insulation; nevertheless it is an active field from the standpoint of insulation and there is a continued study by its own group of specialists. In this direction conspicuous results have been obtained recently in increased knowledge as to the importance of the mechanical design of terminals and flash-over distances in their influence upon the distribution of electric stress and breakdown voltage. Here, progress is directly related to the more fundamental work on the breakdown of gases already discussed.

Problems presented in impregnated paper as applied to high-voltage underground cables comprise another extremely active field. Studies in this field range from the original structure, manufacture, and resulting properties of paper, through a broad series of problems in impregnating oils, into the methods of impregnation and assembly. Another group concerns itself with modifications of the mechanical setup of the cable structure itself—all looking to higher stresses and longer life. Among the more important accomplishments are increased knowledge as to the stability of oils, the separation of the component losses in impregnated paper, better understanding of internal ionization, and many others.

Several investigations—usually accelerated life tests

—as to the influence of residual air and residual moisture in cable insulation are under way. In this connection, problems demanding solution include a suitable accelerated life test on small samples and the law connecting life with voltage and time. Less attention apparently has been given to the question of wax formation in cables, which still remains unexplained. Many improvements in both electrical and mechanical characteristics of various materials for relatively low-voltage insulation have been announced. Noteworthy reports have been made of non-lead-covered insulation for underground service and of rubber insulation having corona-resisting properties.

Increasing evidence of the advantages of oil-filled cable must be given conspicuous mention. Originally developed for the highest voltages, its value in lower ranges now is recognized largely because of the simplification of joints, terminals, oil-feed, impregnation, and other features.

Reference to all this progress would not be complete without mention of the agencies in this country responsible for it. Universities, government agencies, national scientific bodies, manufacturers and public utilities are all uniting in the attack. Each fitted for special types of investigation, their joint efforts insure a steady advance in knowledge.

References to Current Literature

For the convenience of those who may wish to view first-hand the contemporary published record of information that has come to the attention of Doctor Whitehead during the past year, and upon which some of his conclusions are based, the following list is given:

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Conductivity of Insulating Oils

PAPERS by Doctor J. B. Whitehead and by Prof. K. F. Herzfeld present further results from the extended program of research under way at Johns Hopkins University on the fundamental properties of insulating liquids, with special reference to their use for the impregnation of paper. The general course of these studies has indicated that within the normal operating range of temperature the dielectric loss in insulating oils of the better known types can be entirely accounted for by the conductivity as measured for the very short time intervals corresponding to the period of commercial alternating circuits. In the case of impregnated paper, dielectric loss is entirely accounted for by dielectric absorption as measured under continuous potential. Doctor Whitehead's paper is a further study of the short time conductivities, and has revealed for the first time the presence of dielectric absorption in a liquid. The influence of this on dielectric loss is examined. His own abstract follows:

"Continuous-current characteristics of several insulating oils are studied for time intervals beginning 0.001 sec. after the application of voltage or short circuit. Essential equipment is the amplifier oscillograph in connection with a quick-acting switch. It is found that in one group of oils there is an initial conductivity which is constant over the period of the first second following the application of the voltage. Thereafter there is a slow decrease of conductivity to a final value much lower than the initial value. It is shown that this initial constant conductivity is sufficient to account for all of the dielectric loss under alternating stress.

"In another group of more carefully refined and deaerated oils there is superposed upon the brief initial constant conductivity a still shorter initial evidence of dielectric absorption. During the first few thousandths of a second the charging current decreases sharply; is followed thereafter by a constant conductivity up to about one second, and thereafter decreases further to a much lower value after a long time. The initial absorption period has a corresponding discharge curve on short circuit. The measured value of the alternating loss in this case is completely accounted for by the sum of the loss due to the initial period of absorption in combination with the succeeding short-time-constant conductivity.

"Other results are presented on the variations of the initial and final conductivities with the voltage and with temperature. The final currents show saturation characteristics, but the initial high conductivities do not."

In Professor Herzfeld's paper are given results of a mathematical study of Prof. Whitehead's results, looking to a determination of the size and character of the ions involved in the anomalous conductivity of these oils. This question has direct bearing upon the problem of the change in electrical behavior and characteristics of impregnated paper as related to those of its two constituents. Studies of this question also were described in a separate paper, presented at the same meeting by Doctor W. B. Kouwenhoven. Prof. Herzfeld's abstract follows:

"It has been shown in a previous paper how the methods developed in the study of conduction of electricity through gases could be applied to determine the nature of the ions present in liquids and solids. In the present paper these methods have been applied to the measurements (recently performed by Whitehead and Marvin) of the space charge set up in insulating oils by a steady electric field. The procedure is the following:

"The shape of the curve shows that the current must be considerably below three-fourths of the saturation current. It is possible to fit the curve closely by assuming the Langevin constant to be $\beta = 36 \pm 10$. From this the number of ions present in the normal state and their mobility can be calculated, which turns out to be $3.5\ 10^{-6} \pm 50\% \frac{\text{cm.}}{\text{sec.}}$ per $\frac{\text{volt}}{\text{cm.}}$. With that assumption the mobility is of these ions inversely proportional to the viscosity; mobility in water would be $1.2\ 10^{-4} \frac{\text{cm.}}{\text{sec.}}$ per $\frac{\text{volt}}{\text{cm.}}$ or, in the usual units, 12. If one assumes that Lorenz's results for organic ions can be applied, these ions should have approximately 110 atoms. From the boiling point of the oil one would conclude that the molecule of the oils contains about 45 atoms."

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Impregnated Paper Insulation

By F. Hamburger, Jr.

Johns Hopkins University, Baltimore
Associate, A. I. E. E.

THIS abstract of a preliminary report gives some results of a study of the life of impregnated paper insulation under way at the School of Engineering, Johns Hopkins University. The work is being supported by the subcommittee on impregnated paper-insulated cable research of the National Electric Light Association. In an earlier work under the same auspices, a study was made of the influence of residual air on dry impregnated-paper insulation. Results of that study (Vol. 47, No. 1 TRANSACTIONS A. I. E. E., January, 1928) showed the desirability of investigating the effect which different amounts of residual air would have upon the life of impregnated paper insulation. A brief summary of the results so far obtained is given here in the form of eight conclusions, briefly qualified.

LIFE-PRESSURE RELATIONS

A series of accelerated life tests were made on more than 135 samples of impregnated paper insulation in which the only variable was the amount of residual air. Results of this extensive series of tests led to the following conclusions:

1. The life of impregnated paper insulation increases steadily with a decrease in the amount of residual air.
2. The life of impregnated paper insulation decreases rapidly impregnation pressures above 2.5 cm. Hg., absolute pressure.
3. For pressures below 2.5 cm. the normal variations in structure of the samples, particularly tightness, are more important than the amount of residual air.

The pressure range from 40 cm. to 2.5 cm. studied with one compound showed an increase in life from 150 to 2,370 hr. A second compound was used to investigate the pressure range from 2.5 cm. to 2 mm. and in that region the decrease in pressure was accompanied by an increase in life from 4,159 to 6,370 hr. In addition to these conclusions as a direct result of the tests, the necessary preliminary work led to the development of a satisfactory type of sample and reenforced ends for use in accelerated life tests. Several other interesting features have come out of the work which will be treated briefly here.

VOLTAGE-TIME RELATIONS

Accelerated life tests were carried out by means of a step-test in which several different voltages were used. A typical example of the step method used on a number of samples is as follows:

400 Volts per mil for 22 hr.
500 Volts per mil for 22 hr.
600 Volts per mil for 112 hr.
700 Volts per mil to breakdown

Since the step-test was used it was necessary to have some method of correlating the lives of the samples at the different gradients of the test. Investigation led to the adoption of the so-called "eight-power law" as a mode of comparison. From the experience obtained in this connection the following conclusion was reached.

4. The so-called "eight power law" is sufficient for making correlations in such tests as these but leads to unreasonable results if an attempt is made to use it to predict actual life from accelerated tests.

CABLE COMPOUND DETERIORATION

Of the two cable compounds used the first supply was put up in five-gallon cans sealed under vacuum at the refinery. Some of this compound was not used until after it had stood in the containers for seven or eight months; when it was used a marked deterioration was found to have occurred. The second shipment was supplied in 50-gallon drums and was protected from air by the presence of carbon dioxide. Over a period of nine months this compound showed no deterioration. Hence, the conclusion reached is:

5. Cable compound deteriorates even if it contains only a small amount of air, in spite of its being kept in sealed containers. Air should be entirely excluded to avoid deterioration.

POWER FACTOR CHARACTERISTICS

Power-factor characteristics were followed carefully throughout the life-test work; such observations have led to the conclusion:

6. Power-factor characteristics such as the variation of power factor with respect to voltage, power-factor variation with respect to time, or the absolute value of power factor give no indication of insulation life.

PREDETERMINATION OF INSULATION LIFE

The first period of voltage application during the life test, usually 22 hours at 400 volts per mil, was accompanied in almost every case by an increase of power factor. This initial power-factor rise seems to bear some relation to the life of the insulation and leads to a fair correlation which seems to be worthy of calling to the attention of workers in the insulation field. The conclusion drawn is:

7. Power-factor rise due to the initial application of voltage during a life test may be a criterion of insulation life.

This point seems worthy of further study.

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Predetermination of Cable Deterioration

IN abstracting his report "The Predetermination of the Deterioration of Impregnated Paper Insulation," D. W. Roper, Commonwealth Edison Company, Chicago, says:

"All specifications for impregnated-paper-insulated, high-voltage cables, both domestic and foreign, are defective in one respect; namely, they do not insure the stability of the insulation under normal working conditions. Several suggestions have been made in this country and abroad, and the Commonwealth Edison Company has tried all of these tests on samples of 66-kv. single-conductor commercial cable made in the past few years, and it has also tried a few new methods of its own devising.

"While these tests, which have continued over a period of more than two years, have resulted in securing some interesting technical and scientific information, up to the present time they have not discovered any test which could be made within the span of few days and yet be sufficiently accurate to be included in cable specifications as a test for stability of the insulation."

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Chemical Research in the Field of Dielectrics

CHEMISTRY is playing an ever-increasing part in insulation practise. F. M. Clark, General Electric Company, Schenectady, chairman of the subcommittee on chemistry, in abstracting his report, says:

"During the year 1929-1930 there has been unusual activity as reported in the journals covering the chemistry of insulating materials. While major interest has centered in molecular phenomena, the chemistry of insulation testing and the development of new materials has not been neglected. There has developed both in this country and abroad a decided tendency toward the gaging of insulating materials on the basis of chemical aging rather than placing principal reliance on the initial characteristics. This demands improved testing methods. The determination of acidity in both paper and oil by electrometric rather than by colorometric analysis has given the insulation engineers a more satisfactory tool.

"The problem of rating mineral oils for transformer use is still unsolved. Sludge accumulation tests slowly are displacing the older tests based on the formation of first traces of sludge. No decision for or against oxidation under voltage has been made. Studies in the dielectric behaviour of organic liquids such as oil under varying types of electric discharge or under varied conditions for dielectric strength and the relation of these properties to the chemical nature of the material tested should go far in determining the characteristics and the development of new types of liquid dielectrics. The type of discharge has been found to have but little effect on the products formed from the vapors of hydrocarbons, alcohols and organic chlorides. Recent work on the importance of impurities in oil has confirmed the older research results.

"Continued researches during the year have substantiated the hysteresis phenomenon noted in the water sorption curve for paper. The desorption moisture contents are higher than the absorption, due, it is believed, to changes in micellar surfaces of the cellulose. The adsorbed water molecules are held by residual valences. In cotton, the hydroxyl of the cellulose holds adsorbed water. Acetylation of the cotton therefore should result in decreased water adsorption, a prediction in accordance with experiments.

"That the breakdown of solid dielectrics is fundamentally electrolytic in nature is gaining considerable recognition. Whether electric breakdown is thermal or an ionization effect depends according to the newer ideas on the conditions of test. Secondary chemical changes in the dielectric itself or the testing medium may be of major importance in determining dielectric failure.

"Continued study of molecular phenomena during the year has given added confirmation to Debye's theory. Deviations in most cases have been due to the effect of neighboring molecules. Pronounced polarity is doubtless a factor in chemical behaviour, but a large portion of the polarities, assigned by various electron theories of valence, must not be considered as a physical fact but rather as a pragmatic representation of chemical behaviour.

"Careful study of the dielectric constant of organic materials is being pursued to determine changes in both chemical and physical properties. Crystalline formation in inorganic oxides has been shown to produce a drop in dielectric constant. Changes in the dielectric constant of amorphous substances have been approved to indicate crystalline formation. With the recognition of such changes, the synthesis of materials especially designed for the purpose may well be expected as the next step."

A bibliography listing 68 references to current material concerned with the chemical side of insulation research was presented as part of the report of which this is an abstract. Mimeographed copies of that bibliography may be obtained upon application to the Editorial Department, Electrical Engineering, 33 West 39th St., New York, N. Y.

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Relays to Operate in One-Sixtieth Second

A WHOLE new family of quick-thinking, fast-acting relays which operate in a single cycle, and base their decisions not on the customary time elements, but upon comparison of instantaneous values has appeared this year. Together with high-speed circuit breakers, they represent the modern view that continuity of service is best assured by cutting off troubles as fast as possible. All these Westinghouse relays act in one-sixtieth of a second—three to ten times as fast as has been customary.

The *HZ* relay on the left of the illustration, in case of trouble on long transmission lines by means of a little wattmeter element perceives within one cycle which way the fault current is flowing, and estimates the distance to the fault by balancing this current against the voltage drop from the station to the short circuit, thus measuring the impedance.

Transformers or other connected apparatus which develop internal disorders are removed from the system by the *HA* differential relay without the rest of the system being disturbed by the opening of other relays.

High-voltage systems are frequently annoyed by grounds, and this is the specialty of a third high-speed relay; it operates on a comparison between the relative direction of residual line current and current in the

These relays operate in a "split second" grounded neutral of power transformers and is both extremely simple and fast.

Parallel transmission lines have an understanding friend in the *HD* relay at the right. It not only sectionalizes the proper line in the twinkling of an eye, but thoughtfully doubles the tripping value of the line left in service. It operates upon a comparison of the sum and difference of currents in the two lines.

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Tennessee Lightning Investigation Continues

Test results indicate that only one conductor of a line is involved in any one direct stroke; often is one adjacent to approaching storm.

By J. Elmer Housley

Knoxville Power Company,
Alcoa, Tenn.
Associate A. I. E. E.

WITH the general acceptance of the cathode ray oscillograph in 1928 for field investigations of lightning, a cooperative research was undertaken jointly by the Knoxville Power Company and the Westinghouse Company, for which two field laboratories were established near Alcoa, Tenn. The factors governing the selection of this location were the great number of thunder storms and the existence there of a heavily-insulated tower transmission line with two circuits, operating at 150,000 volts. The profile of the line varies from 700 ft. to 2600 ft., following a rugged country with several long river crossings.

The configuration of the cables is vertical on the double-circuit towers with the middle wire 4.5 ft. toward the tower and a vertical separation of about 12 ft. between wires. The single-circuit lines have a horizontal configuration with 17.5-ft. spacing.

The suspension insulators are composed of 10 disks, and the dead-end assembly of each of the triple strings have 12 disks. Horn-gaps are used on the line and ground side and a horn is placed on each side of the insulator string over the axis of the cable in suspension units, and above the insulator in horizontal strings. A half-inch steel ground wire is common to both types of towers.

Cathode-ray oscillograph and related equipment in field laboratory

The stations were located near tower 70 and tower 93 respectively, but the former was too remote from the storms at the ridge of the mountain and will therefore be discontinued.

Three klydonograph installations were established in conjunction with each station. All klydonograph potentiometers were of the three-phase type, one was located adjacent to each station and one on either side of the stations one mile distant. This is illustrated below. The klydonographs are equipped with eight-day clocks and the film records are removed weekly.

The station at tower 70 is a frame building lined with heavy grounded wire screen, and at tower 93 is a sectional steel building grounded at several points.

The equipment in each station is identical. A gasoline-driven 15-kv-a., 110-volt, three-phase, 60-cycle, a-c. generator supplies power for station use. The direct-connected 1-kw. exciter furnishes 125-volt direct current for use in the concentration coils on the oscillograph.

The Norinder oscillograph with its auxiliary equipment, consisting of vacuum pump, switchboard, linear timing device, oscillator and high-voltage rectifier has been used throughout the tests and many improvements have been made in the apparatus and increased reliability has been obtained.

Three-phase potentiometer and Klydonograph installation for lightning studies

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From "Lightning Investigation at Alcoa, Tenn.," presented at A. I. E. E. Southern District Meeting, Louisville, Ky., Nov. 19-22, 1930.

The small number of oscillograms obtained since the stations went into operation do not give a complete picture which would enable an analysis to be made of the waves appearing on the line with their exact point of origin and probable voltages which existed there. The data obtained and observations made during the past three years have been valuable in relation to the development of the cathode ray oscillograph and demonstrated the importance of this device in the field.

Since the location of storms must be very close to the station, chance plays a large part in the volume of data obtained. Accordingly it is hoped that by continuing the investigation over a period of time that a sufficient number of surges will be recorded so that a complete analysis of them may be made. Low-resistance tower footings and ground wire were indicated as desirable for decreasing flashovers.

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Lighting Airway Beacons

High-tension transmission lines may be tapped directly, through the use of a capacitor potentiometer device to supply as much as 3 kw. of electric energy for isolated airway stations.

By F. W. Cartland

Capacitor Engineer,
Westinghouse Electric & Manufacturing Company
Associate A. I. E. E.

RAPID PROGRESS of aviation during the last few years has emphasized the need of adequately lighted airways. Airports have been located near the cities where electric power for floodlights and searchlights was readily available, but the supply of power to airway beacons in isolated places has been a more difficult problem. Beacons in such localities have been operated from low-voltage transmission lines or where these were not available, gas engine-driven generators have been used. The power required for such installations is approximately 2 kw., and low-capacity transformers are available where the system voltage does not exceed 23,000 volts. When higher voltage lines are encountered the smallest standard transformers built vary from 15- to 100-kv-a., increasing with the system voltage. A 100-kv-a. transformer used to deliver only 2 kw. is not only expensive but also inefficient.

A paper presented by Messrs. Spracklen, Marshall, and Langguth at the Winter Convention, February 13-17, 1928, described a potentiometer device for use with condenser type bushings, which supplied sufficient power for operating relays and synchronizing equipment. With the development of high-voltage outdoor capacitors of the suspension type, came the possibility of adapting them to a potentiometer circuit which would supply greater amounts of power than obtained from a condenser bushing. While the capacitor could be thus used to supply very great quantities of low-voltage power, the capacitors as built at present are of such size and construction that it is not considered desirable or economical to obtain more than 2 or 3 kw. from such a circuit.

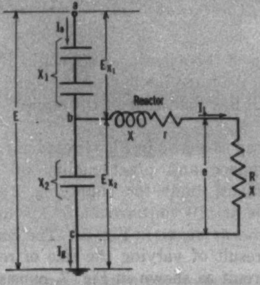

Fig. 1. Theoretical circuit, single line to ground

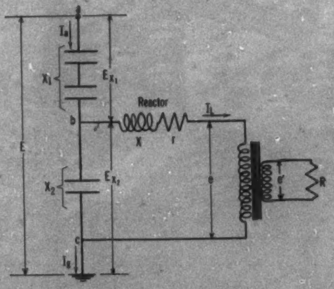

Fig. 2. Single line to ground using small transformer

The capacitor power supply or "capacitap," consists essentially of a number of suspension type capacitors connected in series with a portion paralleled by the load and a reactor in series (Fig. 1). Since in most cases voltage at the load is 110, considering capacitor economy, the use of a small transformer (11,000/110) as shown in Fig. 2 is more desirable. Considering circuits which produce the same voltage regulation, another

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From "Lighting Airway Beacons" presented at the A. I. E. E. Southern District Meeting, Louisville, Ky., Nov. 19-22, 1930.

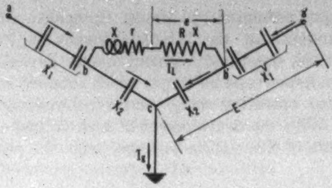

Fig. 3. Theoretical circuit, double line to ground

modification of this circuit, as shown in Fig. 3, has an additional advantage in that the full-load ground current is much less than that of the equipment shown in Fig. 2.

A capacitap as shown in Fig. 4 was built for studying the performance and practicability of this circuit. The equipment, built for supplying 2½-kw. unity power factor at 110 volts from a 66-kv. line, had load voltage curves as shown in Fig. 5. The curve of Fig. 6 shows the result of varying the size of reactor. The complete circuit as shown in Fig. 7, consisted of eight low-voltage capacitors, sixteen high-voltage capacitors shown in Fig. 8, a standard transformer, a reactor and two enclosed spark-gaps. Both transformer and reactor were tapped to give the desired adjustments. Each of the low-voltage capacitors was 0.020-μf., 10,000-volt and each of the high-voltage capacitors was 0.008-μf., 16,000-volt. The reactor was designed for 14,000 volts and had 176 henrys maximum inductance. The spark-gaps were placed in parallel with capacitors *b c* and *b′ c*.

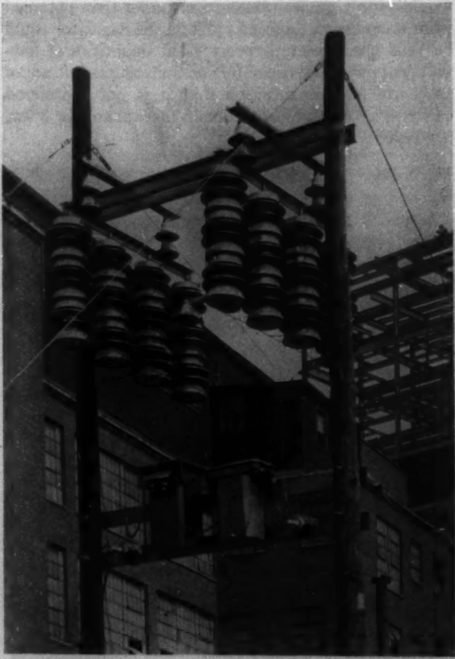

Fig. 4. Close-up of an experimental pole-top installation taking 2½ kw. from a 66-kv. line

The individual capacitor unit is shown in Fig. 8. It is similar in design to those used for carrier current applications, but has a special rating. The construction is such that the capacitor will flash over the outside of the porcelain before it will flash through the inside; the characteristics are similar to those for line insulators; the wet flashover at 60 cycles is 70-kv. and the dry flashover is 116-kv. The weight of each capacitor is approximately 115 lb.

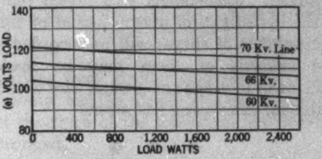

Fig. 5. Load-voltage curves taken from an experimental installation

INSTALLATION

The capacitap may be installed in several ways; by suspending from an existing tower, or from a tower or pole erected especially for carrying this load. The weight of the complete equipment shown in Fig. 4 is about 3000 lb. Although the equipment may be connected directly to the transmission line, the operating companies will probably use disconnecting switches. As this type of equipment may be mounted in suspension, it will be unnecessary to build an enclosing fence as required for equipment mounted on the ground.

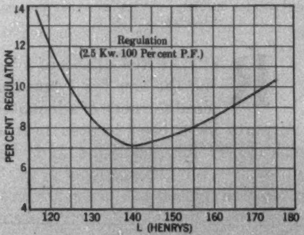

Fig. 6. Curve of regulation vs. inductance of reactor

A study of the various possible circuits has definitely shown that the capacitap may be well adapted to certain classes of loads, while for others the operation would be highly unsatisfactory. For example, either the supply of power to a beacon lamp load or the supply for charging a storage battery through a rectifier would be a satisfactory load; however, the operation of a large motor, or the closing of a circuit breaker would not be suitable. A current surge as encountered in starting a motor should not be delivered by the capacitor power supply as at present designed. Reference to Fig. 9 will show that as the load current increases, the voltage in various parts of the circuit rises, and in all places the maximum voltage must not exceed the rating for which each part is planned. The reactor used in the equipment built for study was designed for 14,000 volts; it will be seen, therefore, from curves of Fig. 9 that the load must not exceed 2700 watts. Also, an overload will cause a current which may saturate the reactor, a condition which would tend to limit the voltage rise on the capacitor. The spark-gaps were installed to protect the circuit from excessive voltage rises.

The capacitap and the transformer both supply low-voltage power from a high-voltage line and there are many things to be considered when choosing between them for any particular application. In general, where less than 3 kw. are required, the transformer will be better adapted to the lower-voltage systems, whereas the capacitap is better adapted to the higher-voltage systems. The dividing line between a high-voltage and a low-voltage system is rather indefinite and will depend somewhat upon the applications. For example, the supply of 2 kw. from a 44,000-volt line (25,400 volts to ground) will be best obtained from a transformer, while the supply of 100 watts at 110 volts for charging a storage battery (through a rectifier) may be economically obtained with the capacitap. For all ratings, the efficiency of the transformers and capacitaps is very high at full load, whereas a 50-kv-a. transformer (high voltage) used to supply 2 kw. will be much less efficient.

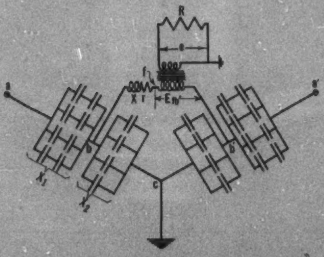

Fig. 7. Complete circuit of equipment shown in Fig. 4

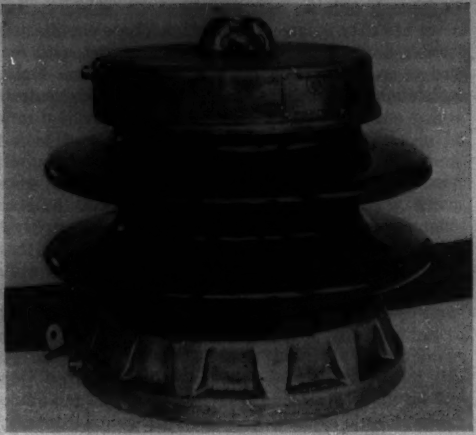

Fig. 8. Single suspension capacitor unit

There are so many variable factors in the design of a capacitap that all study has been limited to a grounded-neutral system; other arrangements adaptable to ungrounded or delta-connected systems will likely follow.

Single-phase power may be obtained from the use of a line-to-ground connection, (Fig. 2) or a double line-to-ground connection, (Fig. 7). Often one may be considered as a substitute for the other, although the inherent characteristics of each will greatly affect the choice. As will be shown later, the double line-to-ground circuit has a ground current which is constant and independent of load; however, the single line-to-ground circuit has a ground current which increases with load. If the ground current should become an important factor—especially in the vicinity of telephone circuits—it would be necessary to consider the use of the double line-to-ground circuit instead of the single line-to-ground circuit.

Another factor which should always be considered is voltage regulation; the nicer the regulation required, the larger and more expensive the equipment will become. The regulation is a function of the total kv-a. of capacitors and the ratio between the impedance of the line and ground branches of the circuit. The single line-to-ground circuit will be found to have slightly better regulation than the double line-to-ground circuit, using the same capacitors in either circuit.

The capacitor power supply (capacitap) is an assembly of capacitors and associated apparatus which supplies power at a reduced voltage from high-voltage lines. The present practical limit is from 3 to 5 kw. Tests have shown that such an equipment has characteristics which are suitable for certain types of loads only—such as airway beacons. The capacitors are very reliable, and being designed for suspension above the ground, with an enclosing fence unnecessary, the factor of safety is large. Two single-phase circuits are possible each having different characteristics with regard to ground current and voltage regulation. Only applications of the capacitap to grounded neutral systems have been considered; it is especially adapted to high-voltage systems.

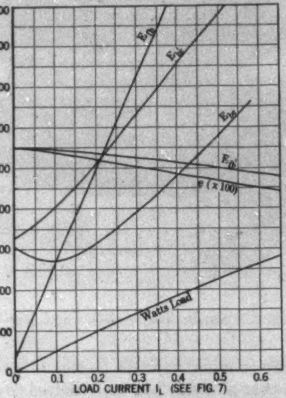

Fig. 9. Load and voltage characteristics

The condenser bushing potential device as developed by J. F. Peters supplied the basis for development of the capacitor power supply, and the author wishes to acknowledge with thanks, Mr. Peters cooperation in the present development.

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Vacuum Tubes Lead the Way

OF all the possibilities which beckon the scientist outside the narrow range of pressure and temperature in which we live, none has shown more alluring results than the family of vacuum or low-gas-pressure tubes. Incandescent lamps, X-rays, mercury rectifiers, radio tubes, photoelectric devices, and hyper-sensitive relays are among the substantial things which have already been summoned forth from the nothingness left by the vacuum pump. Other very practical developments are following; nowadays tangible results follow close upon the heels of theory.

A mercury grid-glow tube under development at the Westinghouse research laboratory, but not yet commercially available, can break 165 kw. (300 amperes, 550 volts) as often as desired, up to even a hundred times a second, with no burning of contacts. The control circuit of this contactor (for such it is in effect) takes so little current it cannot be measured.

This grid-controlled mercury switch is a lineal descendant of the little grid-glow tube which D. D. Knowles invented four years ago. It is in fact a grid-glow tube in which the cathode is a hot mercury pool. It looks like the mercury vapor rectifier to which it is akin; and like it, is started by tilting. The anode, however, at the top of the tube, is totally enclosed by fine nickel gauze (nickel, because it does not amalgamate with mercury). From this anode current flows to the mercury pool at the bottom, the two horizontal electrodes performing the "keep alive" function. A life of several thousand hours is expected. The efficiency is very high—about 99.9 per cent.

The importance of the device is more easily seen by viewing it not for its structure, as a sort of tube, but by its function, as a high-speed, arcless contactor, able to handle substantial amounts of current at any voltage up to several thousand with but a few micro-amperes in the control circuit—a contactor involving no wear of mechanical parts or maintenance, throughout its life.

A grid-glow tube that can interrupt 165 kw.

It already has been used to operate and control motors as large as 10 hp., and with an additional tube, was able also to serve for voltage control.

Some Aspects of

Federal Regulation of Water Power Development

Amazing advance in the use of electric energy during the past decade focuses attention upon the part played by the Federal Government in power development and production. Interesting facts are reviewed here.

By Frank E. Bonner

Executive Secretary
Federal Power Commission
Washington, D. C.

THE PREEMINENT position that has been attained by the United States in the utilization of electrical energy for turning the wheels of industry and lightening the labor burden of homes and farms, makes it of some interest to consider what assistance or encouragement the Government may have contributed toward this result. The primary relation of this industry is with the states, but with the growth of system interconnection, some problems of an interstate nature are beginning to arise. Proposals for their solution through imposition of Federal activity contemplate a minimum of interference with the existing machinery of the state agencies.

It is evident that the contacts of the Federal Government with the manufacturers and distributers of electrical energy have been confined mostly to those which are common to all industries. One prominent exception is in connection with the development of water power. Here through a combination of the Federal responsibility for navigation and the ownership of public land, the Government finds itself a shareholder in many potential water-power sites.

U. S. GOVERNMENT IS LARGEST REAL-ESTATE HOLDER

The fact sometimes is overlooked that the Government is by far the largest real-estate owner in the country. These holdings are concentrated chiefly in the Western states, where vast areas of the original public domain have been reserved for national forests, national parks, Indian reservations, and other purposes. There are also millions of acres comprising the unreserved public domain for which no use, sufficiently profitable, has yet been found.

Three-quarters of all the country's available water-power resources are found in the eleven westernmost states and, as might be expected, many of the potential sites involve United States land. Through the operation of the public land laws prior to the establishment of the policies under which water power and other lands were reserved, the Government's holdings have been reduced to scattered and fragmentary tracts which serve to give merely a minority interest in many important developments. The Government, however, with its sovereign powers may not be dispossessed through ordinary process of condemnation like other small land holders. Therefore, even though its stake in the ownership of numerous sites is small, it is in a position to dictate the terms upon which the entire development may be allowed to proceed. In the exercise of this unlimited authority the Government becomes an important factor relative to many Western projects which otherwise would be controlled solely by the state concerned.

FEDERAL JURISDICTION OVER STREAMS

The interests of navigation which supply the basis for the second element of Federal jurisdiction over certain water-power projects are derived from the fundamental law. The Constitution makes no reference to water power or navigation as such, but Section 8 of Article 1 embraces the following phrase:

> The Congress shall have power . . . to regulate commerce with foreign nations, and among the several States, and with the Indian Tribes.

By these few words the states surrendered to the central Government vast power under which many forms of Federal activity have grown up, including control of the waterways used or useful for the transportation of persons or property in interstate commerce. The definition of navigable waters subject to the control of Congress has been the subject of much controversy. Whether a stream is navigable or not seems to be a mixed question of law and fact.

While uncertainty will arise relative to the navigable status of individual streams, it is evident that many of the country's waterways are subject to Federal jurisdiction, and by the act of March 3, 1899, Congress decreed that "any obstruction not affirmatively authorized by Congress to the navigable capacity of any of the waters of the United States is hereby prohibited." This law has been construed to apply not only to all structures placed in waters actually navigable, but also to such obstructions on non-navigable tributaries which have the effect of substantially impairing the use of "navigable waters" lower down on the stream.

From the foregoing, it is apparent that even though the separate states possess the right to control the use and development of waters within their borders, the

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From "Federal Relations to Water Power Development," presented at the Annual Meeting of the American Society of Mechanical Engineers, New York, Dec. 1-5, 1930.

National Government with its land ownerships and responsibility to navigation holds a basis for participation in the authorization of many water-power projects. Under existing law the administration of these interests is vested with the Federal Power Commission created in 1920. Prior to 1920 authorization for projects encroaching upon Government land or in navigable waters was obtained in various forms and from various agencies. These permits were of a revocable nature, and the difficulty of financing the cost of large works on leaseholds subject to bureaucratic vagaries led to a demand for legislation which would serve to promote the development of water resources.

FEDERAL WATER-POWER ACT

The Federal water-power act of 1920 is aimed to provide a uniform policy under which all of the permissive actions of the Government might be managed. It authorized the granting of licenses which are in the nature of limited leases for 50 years. Development by private capital or public agencies was encouraged to the fullest extent practicable by limiting hampering restrictions and administrative fees to a minimum. Moreover the licensee was assured a stable tenure by the guarantee of reimbursement for the cost or fair value of improvements in case the lease should not be renewed upon its termination. The law thoroughly recognizes the principle that the exercise of Federal jurisdiction should be subordinated to that performed by the states in their rightful fields.

In preference to setting up an entirely independent agency for carrying out the functions of the law, Congress chose to have the work continued by the technical staffs of the departments, composing the Commission of the heads of the three departments concerned. Pursuant to recommendation by the President, the last Congress authorized the substitution of full-time commissioners.

The law now has had ten years of trial, and it seems appropriate that inquiry be made concerning accomplishments and as to whether it is serving to encourage water-power development as intended. This decade has been characterized by enormous growth and expansion in the electric industry; consumption of electrical energy has increased 137 per cent, while the population has grown only 16 per cent. The rapidly expanding demand has created the need for huge new sources of production, and many noteworthy water-power plants have been constructed.

ACTIVITIES POWER COMMISSION

A substantial proportion of the new construction has been carried forward under the provisions of the Federal water-power act. Altogether the Commission has granted licenses for 449 projects. Only 107 of these are in the so-called major classification, larger than 100 hp., the others relate to minor projects and segments of transmission lines crossing Government land. Geographical distribution of the licensed projects shows great concentration in the Western states. California alone accounts for more than a third of the 449 projects, while the three Pacific Coast states together have just about half of the total number. Less than 10 per cent of the projects authorized are situated east of the Mississippi River.

Licenses of chief importance are those covering the 107 major projects, which range in magnitude from small plants constructed to serve isolated communities, to great public-utility developments. The giant generating stations at Niagara, at Conowingo, and on the Sierra Nevada streams of California furnish conspicuous examples of the large modern stations carried out under the existing Federal legislation.

Obviously, many of the proposed projects involve questions of a highly controversial nature, but in handling applications the Commission has moved with such diligence and dispatch that no complaint has been made that construction has been unduly delayed on any legitimate project or that essential interests of the public have not been adequately safeguarded. During the past year the Commission has granted licenses which authorize the installation of more than 1,000,000 hp. During the same period, 30 applications were rejected pursuant to the Commission's endeavors to prevent favorable sites from falling into the hands of speculative enterprises which are unprepared to proceed with construction.

PLANTS UNDER LICENSE

Aggregate capacity of completed plants operating under license amounts to about 2,600,000 hp. This comprises some 25 per cent of all the water-power capacity, and nearly six per cent of the total generating capacity in public-utility service. The Commission has no jurisdiction in respect to water-power developments other than the projects under license, and thus it is apparent that the scope of its authority in respect to the electrical industry as a whole is comparatively limited.

Contrary to popular impression, the Commission has almost no jurisdiction in the field of rate regulation. The law specifically limits the exercise of such functions by the Commission to those licensed projects not controlled by state regulation, and hence there has been little room for the Commission to engage in this function.

Since the authority of the Commission is by no means exclusive in respect to the licensed projects, the administration of the law has required close correlation with the activities of state agencies. In general, these relations have been entirely harmonious and mutually helpful, but at times there has been complaint that the Commission was stretching its authority unduly.

These complaints have related mostly to jurisdiction over projects located entirely on private land along non-navigable tributaries, where the Commission has assumed that the operation of the project works might serve to impair the use of navigable waterways lower down on the stream. The Commission's powers over such developments are rather vague and indefinite under the law, and a number of the states have challenged the Government's constitutional authority. They assert that the assumption of jurisdiction in such cases constitutes a serious invasion of the rights of the states, and interferes unnecessarily with developments of strictly local concern. For guidance in the matter the Commission has recently obtained an interpretation of the law from the Attorney General of the United States. This opinion holds that the Commission, in such cases, may grant licenses embodying terms restricted to those necessary for the protection of navigation. By thus harmonizing the respective jurisdictions of the State and Federal governments so that each may be effective in its proper field, a threatening shadow on the operation of the law will be removed.

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Governor Performance During System Disturbances

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Tests show conclusively that steam-electric generators may lose synchronism and pull back into step without giving any conclusive evidence of that fact either at the generator or in the control room.

IN THE PAST few years, the amount of analytical and test work on system disturbances and stability has increased tremendously, but very little of this theoretical or practical activity has dealt with the operation of steam-turbine governors. During 1929 a detailed investigation was made of the governor operation of the two 50,000-kw., single-cylinder, reheat-type turbines at the Stanton steam plant.

This plant is located near Pittston, Pa., and is jointly owned by the Scranton Electric Company and the Pennsylvania Power and Light Company. The steam connections and valves of the turbine are shown schematically in Fig. 1. All governing normally is done by the main control valve at the first stage of the turbine. Each generator has its own transformer bank and 66-kv. bus. Power normally is supplied by generator No. 1 to the Scranton Electric Company, and by generator No. 2 to the Pennsylvania Power and Light Company. The 66-kv. buses are tied together by a bus-tie reactor. Due to this reactor, generator No. 1 tends to swing with the Scranton Electric Company system and generator No. 2 with the Pennsylvania Power and Light system.

Some preliminary tests were made by dropping and picking up load on one of the turbines to be sure that the governor and all other equipment were functioning correctly under normal conditions of system operation; these tests did not indicate anything erratic in the operation.

Since short circuits were to be placed on one of the lines to the Scranton Electric Company from the 66-kv. bus supplied by generator No. 1, calculations were made to deterime the magnitude of the fault currents and the stability limits of the system under short-circuit conditions. Fig. 3 shows the results of these preliminary calculations, which indicated that the system would be stable with a one-conductor-to-ground short circuit, but unstable with a two-conductor-to-ground short circuit, when the generator was carrying full load. These calculations also showed that if the load on the generator was reduced to 25,000 kw. and the short circuit was cleared in less than ¾ sec. the system would be stable. The tests verified the calculations and are summarized in Table I.

Test No. 12, Fig. 4 shows the record of a two-conductor-to-ground short-circuit test. The output of generator No. 1 was reduced from 40,000 kw. to 22,000 kw. and the generator pulled out of synchronism with the rest of the system before the short circuit cleared, but generator No. 2, which was carrying a load of only

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From "Governor Performance During System Disturbances" presented at the A. I. E. E. Southern District Meeting, Louisville, Ky., Nov. 19-22, 1930.

TABLE I—SUMMARY OF TESTS

Test No.	Initial load in mw. Gen. No. 1	Initial load in mw. Gen. No. 2	Duration of short circuit cycles	Valve control	Stability of system	Fig. No.	Remarks
11	38	30	100	Standard	Stable		1 C. G. Fault
12	40	31	100	Standard	Unstable	4, 5, 6,	2 C. G. Fault
13	25	43	100	Standard	Unstable		2 C. G. Fault
14	25	43	39	Standard	Stable		2 C. G. Fault
20	35	43	..	Standard	..		Load Transfer Test
23	25	43	100	Standard	Unstable	7	2 C. G. Fault
34	38	25	40	Semi-Special	Unstable	5, 8	2 C. G. Fault
50	35	20	..	Special	..	5	Load Transfer Test
51	25	31	98	Special	Stable	10	2 C. G. Fault
52	44	20	19½	Special	Stable		2 C. G. Fault
53	45	20	106	Special	Unstable		2 C. G. Fault

31,000 kw., did not pull out of synchronism. Generator No. 1 increased in speed until it tripped the emergency overspeed governor at 1,960 rev. per min., shutting off all steam input to the turbine. The turbine then drifted down to normal speed and pulled into step with the system 5½ sec. after the short circuit occurred.

A graphic voltage recorder with high-speed feature is normally used to record transient disturbances on this 66-kv. bus. The chart obtained from this instrument during this test is shown in Fig. 5. This chart should also be compared with the voltage chart shown in Fig. 6, which was taken during this test by means of a high-speed photographic recorder. This later type of instrument gives a true picture of the voltage conditions and the comparison illustrates the limitations of graphic instruments as recorders of fast transient phenomena.

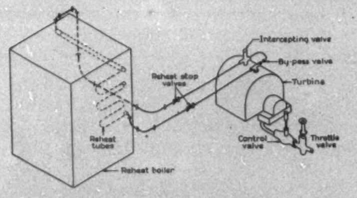
Intercepting valve
By-pass valve
Reheat stop valves
Turbine
Reheat tubes
Control valve
Throttle valve
Reheat boiler

Fig. 1. Schematic diagram of piping and valves for turbines tested

Test No. 23. Calculations had indicated that generator No. 1 would be stable with loads up to 25,000 kw., and a two-conductor-to-ground short circuit duration of less than ¾ sec. A two-conductor-to-ground short circuit was thrown on the system with a 25,000-kw. load on generator No. 1, but due to the relay setting which kept the short circuit on for 1.7 seconds, the generator again went out of synchronism, but did not trip the emergency overspeed governor. Generator No. 2 being heavily loaded (43,000 kw.) lost synchronism with the rest of the system and tripped the emergency overspeed governor. Violent oscillation of the governor beam of generator No. 1 occurred before it resynchronized. Fig. 7 shows the results of these tests.

The relay setting was changed to reduce the short-circuit time to 0.65 seconds and the short-circuit test was repeated. The generators did not lose synchronism, which shows the value of short switching time.

GOVERNOR PUMPING

Load Transfer Tests. Several operating companies have reported that during certain system disturbances the governor beams of the turbines have oscillated, and that this oscillation has continued for two or three minutes, or until some means was taken to correct the condition, such as holding the governor beam or disconnecting the turbine from the system. This phenomenon has been termed generally "governor pumping" and should not be confused with governor hunting which is a slow, periodic movement caused by lag of the valve behind the governor.

Load transfer tests were first made to determine if governor pumping could be produced by a disturbance of a minor magnitude but were unsuccessful.

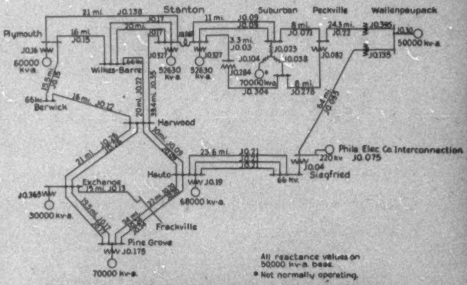
Plymouth
Stanton
Suburban
Peckville
Wallenpaupack
21 mi. J0.138
16 mi. J0.15
J0.16
60000 kv-a.
20 mi.
J0.17
J0.327
52630 kv-a.
11 mi.
J0.09
J0.327
52630 kv-a.
3.3 mi. J0.03
J0.104
J0.284
J0.023
J0.038
70000 kv-a.*
J0.304
8 mi. J0.278
8 mi. J0.071
J0.082
24.3 mi. J0.22
J0.386
J0.30
50000 kv-a.
J0.135
Wilkes-Barre
66 kv.
13.5 mi. J0.15
66 kv.
Berwick
16 mi. J0.12
20 mi. J0.22
19.4 mi. J0.35
Harwood
64 mi. J0.093
10 mi. J0.09
21 mi.
Phila. Elec. Co. Interconnection
220 kv J0.075
23.6 mi. J0.21
J0.04
Siegfried
66 kv.
Hauto
J0.19
68000 kv-a.
Exchange
15 mi. J0.13
J0.365
30000 kv-a.
19.5 mi. J0.17
22 mi.
Frackville
Pine Grove
J0.175
70000 kv-a.
All reactance values on 50000 kv-a. base.
* Not normally operating.

Fig. 2. Single-line diagram of interconnected systems involved in governor tests; only equivalent circuits shown for some parts

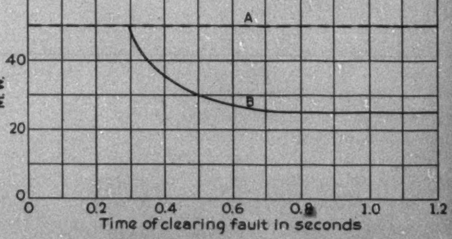

Fig. 3. Power capability of No. 1 generator plotted against switching time; (A) rated megawatts output, (B) output with two-conductor-to-ground fault outside generator transformer

Test No. 34. This was a two-conductor-to-ground short-circuit test in which the generator lost synchronism but did not trip the emergency overspeed governor, so that the speed governor still controlled the steam input. Reduction in the generator output due to the loss in synchronism, coupled with the normal speed-regulating characteristics of the governor, resulted in a sustained prime-mover speed above that of the system.

Fig. 8 shows the results of this test. During the first 2.5 seconds the movement of the main control valve was controlled by an auxiliary pilot valve which was being used in a preliminary form in an attempt to keep the turbine in synchronism; this pilot valve, however, had no effect on the governor or control valve after this initial period. Seven seconds after the short circuit occurred the governor mechanism started to oscillate at a period coinciding exactly with the kilowatt oscillation of the generator. The speed curve shown is a composite curve, composed of an average-speed curve obtained from the oscillograph record, and a superimposed speed change calculated from the output of the generator and added to the average-speed curve. From this composite curve it may be seen that if the governor follows the speed of the turbine it must alternately open and close the control valve an appreciable amount. The curves show that the governor was doing its best to follow these speed changes, although with about ¼ second time lag, and thus was varying the steam input in accordance with the speed, which is what a speed governor is designed to do.

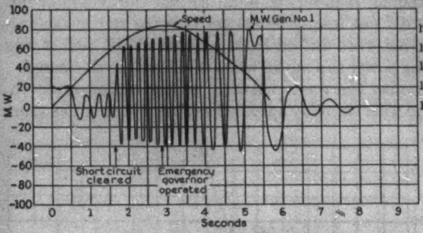

Fig. 4. Test 12. (Two-conductor-to-ground fault) shows No. 1 generator unstable, No. 2 stable

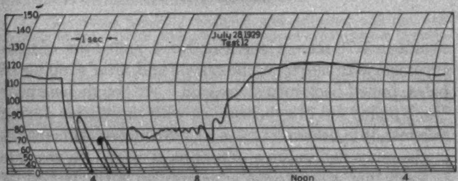

Fig. 5. Test 12. Graphic voltmeter chart from 66-kv.

Fig. 6. Test 12. High-speed photographic record of ground current and voltage; (A) fault ground current, (B) voltage, phase 1-N, 66-kv. bus, (C) voltage, phase 3-N, 66-kv. bus

During the interval from the third to the seventh second, the periodic speed change caused by the generator slipping poles was so fast that it was impossible for the control valve to follow it. However, as soon as the average turbine speed came down to a point where the governor mechanism and control valve could follow the periodic changes in speed, the control valve started a pumping movement in which it assumed the proper position corresponding to the speed. This pumping of the governor beam was therefore a normal action and should be expected under conditions such as existed at the time of its occurrence.

Fig. 9 shows the speed-regulation curve for the governor of this turbine at the load carried when this test was made. If the turbine was completely unloaded it would run about five per cent above the normal system speed. The figure also includes a curve showing the relation between speed of the turbine and the induction-generator output of the generator for the voltage conditions which existed on this system during this test. The point where the induction-generator curve crosses the speed-regulation curve determines the speed of the turbine and the load which it will carry when it is out of synchronism. The average output of the generator during the period covered by the curves was about 13,000 kw. and the speed was about 3.3 per cent above normal.

TESTS WITH SPECIAL VALVE EQUIPMENT

In the previous short-circuit tests, all really severe system disturbances were accompanied by a loss of synchronism of one or both of the generators. The possibility of holding this turbine in synchronism by rapid reduction of input steam following a system disturbance seemed in this case to justify investigation. A special power-surge relay and a valve mechanism were designed therefore to shut off the steam input to the turbine by closing the main control and intercepting valves temporarily when a short circuit occurred. In order to obtain a fast reduction in steam input to the turbine it was necessary to operate both the control valve and the intercepting valve on the reheat loop.

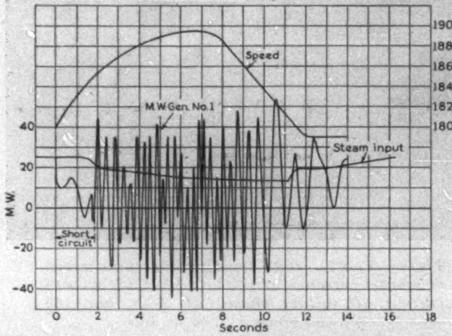

Fig. 7. Test 23. Both generators unstable and out of step with system and each other

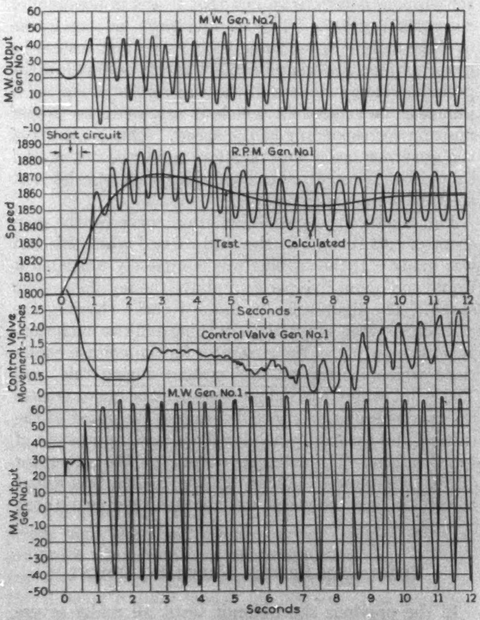

Fig. 8. Test 34. Governor and control-valve pumping

Test 51, Fig. 10 shows the results of a two-conductor-to-ground short circuit on the 66-kv. bus with the kilowatt load on generator No. 1 the same as for tests Nos. 14 and 23, and the short-circuit time the same as for test No. 23. The load on generator No. 2 was, however, somewhat reduced from its previous load. The steam input curve on this figure shows how the high-speed valve mechanisms used in this test, but not in tests Nos. 14 and 23, reduced the input so that the generator not only did not lose synchronism with the rest of the system, but even drifted back in angle so fast that it was taking power as a motor when the short circuit cleared.

Another test was made with full load on generator No. 1, and with the relay adjusted so that it cleared the short circuit in 1.78 sec. Generator No. 1 pulled out of synchronism with the rest of the system and, after slipping 16 poles, pulled back into step again. Although generator No. 1 pulled out of synchronism with the system during this test, it is believed that by a few further refinements in the relay and valve mechanism, it would be possible to keep this generator in synchronism with the rest of the system even for short circuits as severe as in this test.

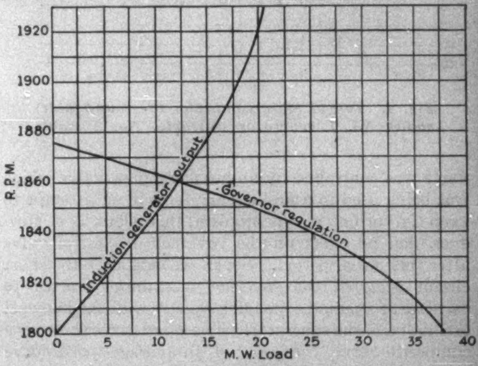

Fig. 9. Test 34. Turbine regulation and induction-generator power

These tests evidence the possibilities of this method for improving system stability and indicate results which are comparable with those obtained by the use of the more commonly proposed means for attaining the same end.

General Summary of Results

Results obtained shed additional light on some phenomena which have occurred during system disturbances and lead to the following general conclusions:

1. It is possible for a generator to lose synchronism and pull back in again without giving any conclusive evidence in the control room or at the turbine that such a change has occurred. Graphic charts and indicating instruments are not fast enough to indicate out-of-synchronism conditions reliably. Thus, this condition occurs far oftener than has been generally appreciated.

2. Cases of sustained system oscillation, or surging, seldom occur unless some generator, or group of generators, loses synchronism. Any oscillation resulting from a disturbance that is not sufficiently severe to cause loss of synchronism quickly dies out, due to the inherent system damping.

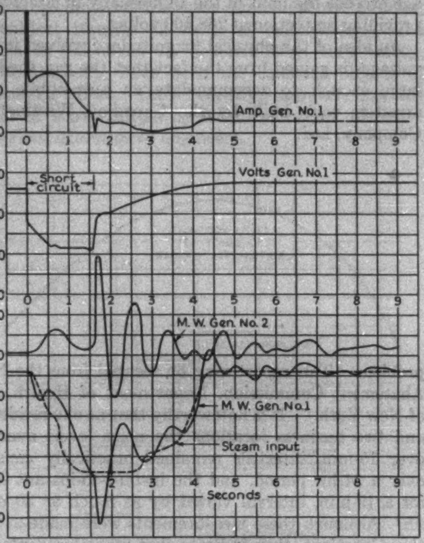

Fig. 10. Test 51. With special valve equipment both generators are stable

3. Governors properly designed and adjusted will not contribute to any system oscillation as long as synchronism is maintained. When out of synchronism, however, the governor attempts to follow the speed change as the generator slips poles, and the result is a "pumping" phenomenon familiar to many station operators. This pumping action is a result rather than a cause of a sustained oscillation and is to be expected when the generator and the system are out of step at a certain slip frequency. It will cease if the generator pulls back into synchronism.

4. When out of synchronism the speed of the turbine is determined by the regulation of the governor and the induction generator characteristics of the generator. The average output during this period may be an appreciable portion of the output before loss of synchronism.

5. In these tests the short circuits resulted in considerable reduction in the kilowatt output of the generators with consequent overspeeding and loss of synchronism. Special valve equipment for quick reduction of steam input following a sudden drop in generator output will increase the stability limits. Under certain conditions it may be of considerable benefit in maintaining stability, but under other conditions the equivalent improvement in stability may be better obtained by other means.

The authors wish to express their appreciation of the cooperation of Messrs. C. H. McKnight and J. E. Geue of the Stanton Operating Company in the performance of these tests and arrangement of system operation with connecting companies. They also wish to acknowledge the assistance of Mr. R. H. Park who initiated the tests with the high-speed valve mechanism, Mr. J. W. Dodge for assistance in the preparation of the test results and Mr. D. M. Jones for criticism of the paper.

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Lightning Arresters for 268.4-Kv. Service

THE highest-voltage lightning arresters ever built were recently installed by the Hydro-Electric Power Commission of Ontario. Under emergency conditions they will protect line voltages as high as 268,400 volts. This is also the largest arrester installation for voltages over 200,000. One three-phase arrester protects each of four banks of transformers on

These lightning arresters act automatically to protect against effects of waterwheel overspeed the 220,000-volt transmission line from Paugan to Leaside.

The disparity between the 268,400-volt rating of the arresters and the normal line voltage of 220,000 is a recognition of the inherent tendency of waterwheel generators, if the load is suddenly dropped, to overspeed, carrying the line voltage far above normal. Ordinarily, this situation has been met merely by using arresters rated high enough to withstand the maximum voltage without discharge. But this means that the line has less protection against lightning than were the arresters of only normal line voltage.

The Hydro-Electric arresters meet the situation by having a double rating, changing from one to the other automatically in emergency. Of the series of 22 autovalve units in each phase leg, only 18 are necessary for 220,000-volt protection, and normally the other four are short-circuited by a high-speed automatic switch. When waterwheel overspeed and over-voltage occur, a relay opens this switch in less than half a second and cuts in the four remaining elements before the line voltage exceeds the limit of the 18 normally in circuit, thus providing protection at 268,400 volts.

An idea of the physical magnitudes involved in such voltages is gained from the fact that the gap sheds are large enough to accommodate an automobile. The arresters were built by the Canadian Westinghouse Company, Ltd.

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Noise Measurements

That noises have a detrimental effect upon human health and happiness has been proved and now efforts are under way to control or eliminate objectionable sounds. Some of the problems involved are outlined and a newly developed "noise meter" is described.

By John C. Steinberg

Bell Telephone Laboratories, Inc.

THE INCREASING number during recent years of papers and editorials on city noise is evidence of a thriving interest in this aspect of modern life. People are questioning the necessity of this or that noise; makers of machines are looking for ways and means of attaining quieter operation; office and factory managers are asking about the effects of noise on the efficiency of employees; doctors and health officers are becoming interested in the effects of noise on the health of communities; and so on. Noise in this broad sense refers to any audible sound which is undesirable or which intrudes.

Within the past year there has been formed by Health Commissioner Wynne, the Noise Abatement Commission of New York City, and some 10,000 actual noise measurements have been made on the streets of New York. (A recent book, *City Noise*, by the commission, gives a comprehensive report of these measurements as well as other aspects of the noise abatement problem. This report may be secured from the Noise Abatement Commission, Department of Health, City of New York.) It is noteworthy that at one residential and two business locations the noise levels averaged over 15-min. intervals remained practically constant over a 24-hr. period, and the instant-to-instant levels for a 15-min. interval varied by as much as 30 or 40 db. Although these measurements were made at only three locations, they indicate that many residents of a large city are constantly immersed in a sea of noise, the average level at 3:00 a. m. being only a few decibels lower than the level during busy hours.

At this point it may be well to digress to the extent of making clear just what the term decibel really means. On the decibel scale, the unit is actually about equal to the smallest change which the ear can detect in the power level of a sound. Thus it is a ratio of intensity based upon the minimum audible unit; for instance, if the intensities of two sounds are in the ratio of 10:1, the sounds differ in level by 10 db.; if the ratio of intensities is 10^2:1 (100:1), the sounds differ by 20 db. In general, the number of decibels measuring the difference in level between two sounds is ten times the common logarithm of the intensity ratio, or power ratio.

It is a well established fact that constant exposure to noise takes its toll in the form of the extra energy needed to carry on the normal living processes with a consequent more rapid deterioration of the physical and nervous system. Experiments with typist and comptometer operators working under noisy and quiet conditions have shown that the effect of noise is to reduce the rate of accomplishment and to increase the rate of energy consumption by the body. (*Effect of Noise on Working Efficiency*, D. A. Laird, Loc. Cit. 1, and *The*

Based upon an oral presentation at the A. I. E. E. Middle Eastern District Meeting, Philadelphia, Oct. 13-15, 1930.

Effects of Noise, D. A. Laird, *Journal* Acoustical Society Jan. 1930.) Some of its physiological effects are an increase in brain pressure; a lessened regularity of the involuntary muscular changes of body organs such as heart rhythm, stomach rhythm, etc.; an increase in body movements during sleep; and probably in some cases a definite neurosis.

Since machines are the most common source of noise, the subject touches all fields of engineering. Such aspects of machinery as dependability, cost, safety, appearance, etc., have been the constant objects of engineering effort. Only recently, however, has the matter of noise emitted by machines begun to receive the serious attention of engineers.

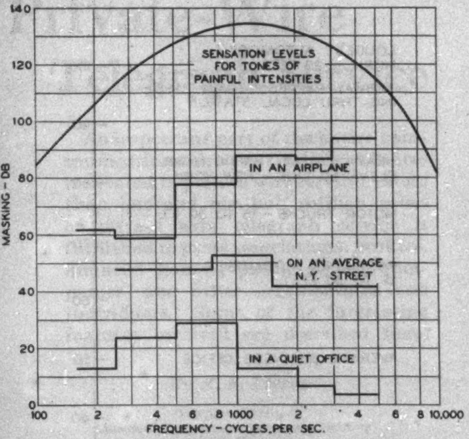

Fig. 1. An audibility chart showing how noises rob the human ear of an important part of its total range

Any study of noise naturally calls for a method of measuring and expressing the amount of noise. From a physical standpoint, this may be done in terms of the total sound energy and its distribution in frequency, and various methods have been devised and used to measure the physical energy of sound waves. For many purposes, however, it is desirable to express noise in terms that are more nearly related to the sensation caused by sound energy.

One method of doing this, called the audiometric method, is based on the fact that noise or the undesired sound masks other or desired sounds. ("Speech and Hearing," H. Fletcher, D. Van Nostrand Co., 1929, and "Auditory Masking," R. L. Wegel and C. E. Lane, *Phys. Rev.*, Feb. 1924.) If a certain intensity is necessary for a sound to be barely audible in a quiet place a greater intensity will be needed in the presence of noise. This shift in threshold is expressed in decibels; *i. e.*, ten times the common logarithm of the intensity ratio, and depends upon the intensity frequency spectrum of the noise.

If the masking caused by noise is observed with tones of different frequency, noise audiograms of the type shown in Fig. 1 are obtained. Two of these were with tones warbling through six different frequency ranges, and one with tones warbling through three different ranges. The curves illustrate three types of audiograms in which with increasing frequency the masking respectively increases, remains approximately constant, or decreases. As indicated above, the audiogram curves are "threshold-of-hearing" curves and the effect of noise is equivalent to a temporary hearing loss. In Fig. 1 the direction of increasing hearing loss is in the direction of the positive Y-axis, which is the opposite of the conventional way of plotting audiograms for the hard-of-hearing. (Loc. cit. (3) p. 199.) In the latter case, attention usually is focused on the hearing loss or upon how far the hearing is down from normal; in the former case, attention usually is focused on the amount that the intensity of a sound must be increased above normal to be audible in the presence of noise.

Useful hearing area in Fig. 1 is that below the curve for tones of painful intensities. The areas below the audiogram curves represent the parts of the useful area which are rendered useless by the noises. In order to be appreciated by the ear, sounds falling within these areas must be increased in intensity to a part of the area above the audiogram curves. For example, average speech as heard at a distance of from three to four feet from the speaker occupies the area between 60 and 70 db. Therefore, on an average New York street, it is only slightly above audibility; and in an airplane cabin becomes entirely inaudible.

The noise audiogram shows directly the loss in serviceable hearing caused by noise. For this reason it is very useful in many noise studies, particularly in the communication field and in the acoustic treatment of auditoriums, theaters, offices, etc., or where the chief concern is the perception of desired sounds in the presence of undesired sounds.

Amounts of noise may be expressed in terms of the sensation level and in terms of the loudness level of the noise. The sensation level is the ratio, expressed in decibels, of the noise intensity to the threshold intensity of the noise. If the intensity spectrum of the noise is known, the sensation level in most cases may be determined from the known minimum audible intensities of pure tones. The loudness level of a noise is usually expressed as the sensation level of some arbitrarily selected reference tone which sounds as loud as the noise.

Masking caused by a noise is measured by adjusting the intensity of a tone from a telephone receiver until it is just audible in the presence of the noise. The receiver is provided with a special offset cap which holds the receiver away from the ear by a small amount, so that noise may enter the ear simultaneously with the tone. The attenuator which is used to adjust the intensity of the tone is calibrated to read the masking in decibels. In one type of noise audiometer ("Methods and Apparatus for Measuring the Noise Audiogram," R. H. Galt, *Journal* Acoustical Society, Oct. 1929) a series of so-called "warbling" tones is used. These are tones which warble through a small frequency range, the range corresponding to each tone being located in a different part of the audible frequency range. Thus the masking caused by the noise is measured in different frequency ranges and when plotted against frequency gives curves of the type shown in Fig. 1. In another type of audiometer (Loc. Cit. 3) the masking is measured with a so-called "buzzer" tone, which consists of a fundamental frequency of 160 cycles and harmonic overtones, the overtones extending throughout a large part of the audible range.

The loudness level of noise is measured by adjusting the intensity of a reference tone until it sounds as loud as the noise. In this method, known to communication engineers as the balance method, the buzzer type of tone is used as a reference tone in some cases and in other cases, a 1,000-cycle pure tone is used.

In all of the above methods the ear is used in obtaining a judgment of the effects of noise. During the past two years considerable experimental work on devices to represent the effect of noise by the reading of an electrical meter has been done by various investigators of noise. (*A Survey of Room Noise in Telephone Locations*, Williams and McCurdy, A. I. E. E. Jour., Sept. 1930; "Practical Methods of Noise Measurement," by E. E. Free, *Journal* Acoustical Society, July 1930 "The Objective Measurement of Machinery Noise, by F. A. Firestone, *Journal* Acoustical Society, July 1930; "Results of Noise Surveys," R. H. Galt, *Journal* Acoustical Society, July 1930.) In all of these devices the noise energy is picked up by a microphone, suitably amplified and rectified and measured by a d-c. meter. The action of the devices is made to approach that of the ear by means of a "frequency-weighting" network. In some cases the weighting is based on the threshold intensities of pure tones; in other cases, on the intensities needed for pure tones to sound equally loud at some arbitrary loudness level. Although where the time characteristics and manner of integrating the components enter in such a procedure does not completely simulate the ear in its action to complex waves, it represents an advance over any method which neglects the ear entirely.

In most cases, noise meters of this type are calibrated to read the noise level in decibels from some arbitrary reference or zero value, such as the meter reading for a "just audible" tone or noise of a particular type. Noises having equal meter readings are approximately equally loud, the degree of approximation depending upon the similarity in energy frequency distribution of the noises being compared.

Noise meters of this type were used in both the N. Y. Noise Abatement Commission Survey of outdoor noise, and the survey of indoor noise by the joint subcommittee of the National Electric Light Association and the American Telephone and Telegraph Company. The frequency-weighting in these meters was based on the intensities needed for various pure tones to sound as loud as a 1,000-cycle tone having a sensation level of 30 db. Readings which would correspond to the threshold of audibility for a common type of noise were obtained for both meters by reproducing street noise phonographically at a known sensation level. Thus, measured noise levels could be expressed in decibels from the threshold settings. A graphical illustration of the noise level scale is given in Fig. 2 where the levels of

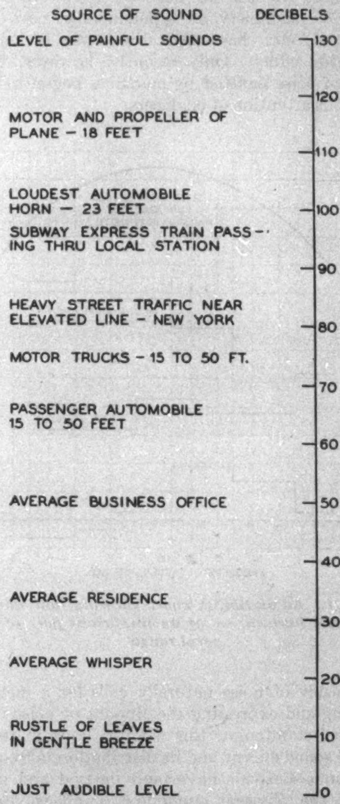

Fig. 2. A chart showing the decibel rating of some common sounds as compared to the "threshold of hearing"

some of the more familiar noises encountered in the surveys may be compared. The total range from threshold to painful sounds is 130 db. It may be seen that ordinary noises cover a large part of this range.

As previously indicated, noise meters such as that described are still in the experimental stage. In order to indicate loudness accurately for all types of sound waves, a meter must simulate the ear in at least three respects:

(a) In the relative sensitivity for sinusoidal waves of different frequencies.

(b) In the integration or summing up of the contributions of the component waves of steady complex sound waves.

(c) In the short-time average of fluctuating complex sound waves.

Further experimental work is needed in order to simulate the ear closely in all of these respects in a practicable noise meter and to determine the effects of various departures on practical noise measurement. The outstanding advantages of the objective type of measurement are that it reduces the personal equation and permits noise measurements to be made with great rapidity.

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Private-Wire Telegraph Service

An important part of the entire communication service of the United States is devoted to private wire service. More than one and one-half million miles of private wire telegraph service is furnished to press associations, brokers, financial houses, public service companies, and other organizations and individuals. Some of the interesting features involved are described here.

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Associate A. I. E. E.

TELEGRAPHY has the distinction of being the earliest application of electricity in the service of mankind, and it still reigns as an important factor in commercial, educational and social activities. The commercial telegraph message business is essentially a point-to-point service and the telegraph facilities are designed and operated for the most part so as to furnish direct communication channels between two points. The private wire telegraph service, however, usually requires circuits with sending and receiving equipment at more than two points,—often at many points—and because of this fact the engineering problems involved are somewhat different from those in the commercial telegraph field.

Another unique feature of the private wire telegraph service is the fact that it is furnished very largely over plants which are used jointly for telephone and telegraph purposes. Thus if the private wire subscriber having printer service wishes to communicate with the attendants in charge of the maintenance of his service, he has merely to call on the telephone provided for the purpose, usually mounted adjacent to the printer installation. Immediately he is connected directly with the attendants at the printer service position in the nearest telegraph test room. In case of difficulty on the circuit, the telegraph attendant can communicate immediately with distant repeater attendants over test wires provided for the purpose, and with the monitoring printers, can make measurements over the private wire network in question. Transmission measuring apparatus and other testing means are also at his disposal.

The term "private wire telegraph service" as used in this paper covers that type of service by which a complete telegraph communication system is furnished to the patron for his exclusive use; this type of service is sometimes referred to as the "special contract" telegraph service. In that all facilities, including the station apparatus at the patron's premises, are furnished and maintained the service is complete. A circuit may be arranged for either the manual or machine method of operation to suit the requirements of the organization using the service, but since it is the term most universally used, throughout the paper the machine method will be referred to as the "printer method." Other terms in use by various organizations to describe the same method are "typing telegraph," "telephone typewriter," "teletype" and "teleprinter."

COMPARISON OF PRINTERS

The two systems of pointers in common use, the "multiples" and the "start-stop printer," differ in one important feature. In the multiplex system the signals

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From "Modern Practises in Private Wire Telegraph Service," to be presented at the A. I. E. E. Winter Convention, New York, Jan. 26-30, 1931.

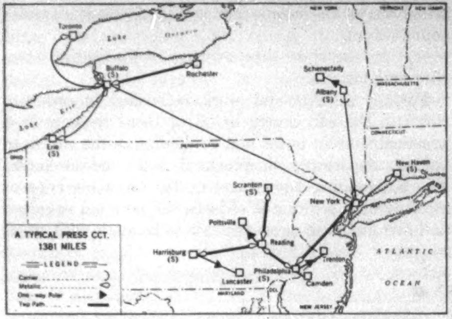

Fig. 1. Typical private press circuit involving 1,381 miles of line

are transmitted to the line and from the line to the receiving apparatus by distributing mechanisms which are operating continuously in approximate synchronism. In the start-stop system the signals are transmitted to the line and from the line to the receiving apparatus. These mechanisms start from a given position, transmit one character and then stop. In this latter arrangement the maintenance of synchronism between the sending and receiving devices is necessary only during the transmission of one letter or character. The multiplex system is essentially a point-to-point system, whereas the start-stop system is adapted to circuits involving a large number of stations, any one of which may send or receive. The advantage of the continuously synchronized system of transmission is the possibility of using a shorter code; it is necessary to transmit only the intelligence-bearing signals, whereas in the start-stop system a signal is sent to start, and another to stop the distant distributor mechanism.

The fundamental advantage of start-stop over continuously synchronized systems is the fact that in the start-stop system the lag in the transmission of a signal from one point to another point in a circuit is automatically taken into account. With only two stations on a given circuit an initial adjustment can be made to properly orient the receiving device with respect to the sending device which will hold as long as the lag remains fixed. With more than two points in a circuit—any one of which may send to all the others—or with transmission systems which are apt to be changed in a way that affects the lag, the adjustment to compensate for lag becomes difficult if not impracticable. This feature would restrict considerably the field of use for continuous synchronism in private wire telegraph service, where such a large portion of the circuit requires service between more than two points, and where it is essential to maintain a flexible plant in order to maintain continuous service. This explanation will indicate why the multiplex system, designed as a continuously synchronized system, is used in the commercial telegraph message service while the start-stop system is used in the private wire telegraph service.

SELECTIVE DIAL CALLING

For services where it is desirable to select particular stations yet impracticable to provide a switchboard with individual circuits to each station, a selective calling arrangement has been developed. With this plan all stations are connected to the same circuit and selective signals are transmitted from one station to another over the circuit used for passing the telegraph signals. The apparatus used to accomplish this consists of telephone dials, step-by-step switches, and relays. Any point on the circuit may be called by dialing any other point on the circuit. A station may also dial by a single three-digit code all other stations or a group of stations. When the circuit is in use, "Busy" signals appear at all stations, and an audible or visible alarm is provided to call the attention of the attendant to an incoming message. When the station is idle the motors of all printers are stopped but start automatically when the station is called and stop automatically when a call releases the circuit. Secrecy is obtained in the system through the fact that it is impossible for a station which has not been called to "listen in" on a circuit in use.

INDUSTRIAL APPLICATIONS

The foregoing gives briefly the general principles of the systems of private wire telegraph service in general use in this country. The following describes special application of private wire systems to various industrial systems:

Press Service. Private wire telegraph service is the means used by the press association for accomplishing quickly, accurately, and without interruption, the collection and distribution of news. A typical telegraph network—one of the many circuits of one of the leading

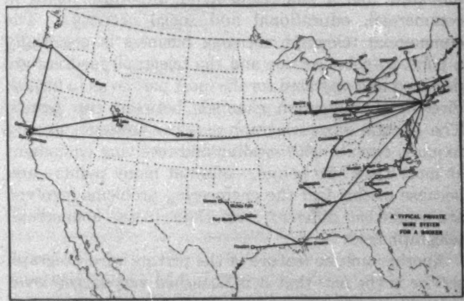

Fig. 2. A broker's private circuit may be the equivalent of several transcontinental circuits

Fig. 3. A broker's private wire room is a busy place

press associations in the United States—is illustrated in Fig. 1. It will be noted that this network contains approximately 1,400 mi. of telegraph circuits and connects sixteen telegraph stations, five of which are arranged for both sending and receiving while eleven are for receiving only. The various types of telegraph systems involved in this particular service are indicated by the designations on the chart.

In a service of this kind most of the sending would be done from New York; it will be noted, however, that there are other points on the network indicated as sending stations. The circuit must be arranged with "break" feature so that when desired, any one of these other sending stations may take control of the entire network and transmit to all stations. To accomplish this the operator at the station transmitting the message operates the break key on his machine which transmits a break signal over the circuit, locking up the machine which has been sending and thereby indicating to the operator at that point that another station wishes to send.

In most cases the printers involved in the press work are of the page type, using a continuous roll of paper. The sending machines are usually equipped for what is known as automatic transmission; the sending operator manipulates a keyboard which controls a perforator. This perforator prepares the message to be transmitted in the form of a perforated tape to be fed into a transmitter connected to the line. The transmitter is operated at a speed for which all the printers on the line are set; the perforator may be operated at any speed desired. If the speed of the line is exceeded by the perforator (as is usually the case) the message is stored up in the tape and is transmitted to the line at a regular rate. With this method of transmission there is a continual flow of traffic over the line and any interruption in the operation of the keyboard does not interrupt the signals going to the line. This arrangement obtains the maximum efficiency from the line.

In certain cases a "bulletin" or "flash" of special importance must be transmitted; arrangements are provided so that by throwing a key the transmission of signals from the perforated tape is stopped and the keyboard is connected directly to the line so that as each key is depressed the proper signals are transmitted. In this way the "bulletin" or "flash" may be sent without delay directly to the line from the keyboard, and when it is complete, the regular flow of traffic may be resumed by restoring the key mentioned previously. In order to attract the attention of the operators at the newspaper offices to such a flash or bulletin, a bell is provided on the printers and caused to ring by the transmission of a particular combination of impulses from the sending keyboard.

Brokers' Service. A large percentage of the business involved in the trading on the stock and commodity exchanges is handled over the private wire systems of the various brokerage concerns. Fig. 2 shows a typical broker's service which comprises several separate circuits. This service is operated by the printer method, and Fig. 3 is a view in one of the wire rooms of this brokerage house. In the brokerage houses the wire network is used for passing information regarding orders placed before the market opens, and for distributing certain market letters or market "gossip." When the market opens, the wires are kept busy with the passing of orders, confirmations, and questions and answers concerning specific securities. From the illustration it will be noted that the tape printer is used and the cover of the machine cut away in such a fashion as to allow the tape to be removed from the machine immediately after the last character of an order is printed. The orders are gummed on "buy" or "sell" order blanks and are then handled in the usual way. In the afternoon after the market closes the wires, in cleaning up the day's business, continue to handle a large volume of traffic; the records are checked and verified and all matters cleared before the opening of business on the following day. It is reported that during four days of

Fig. 4. Telegraph printer systems are expediting and amplifying effective police work

the record month of October 1929, one of the brokers using this service handled the remarkable total of 49,860 orders, confirmations, and general messages over the firm's six private wire telegraph circuits.

Police Systems. Various police organizations throughout the country are finding the private wire telegraph service a reliable means of quickly disseminating police information. These police systems are essentially broadcasting networks for transmitting police information simultaneously to a large number of receiving stations from one or more central points. The information usually originates in a telephone call or a personal visit to a police station from which the information can be quickly transmitted to the central headquarters and from there sent out on the broadcasting network. Regardless of whether or not the station is attended the receiving machines make a record of the message. In certain cases the receiving machines are equipped with an audible alarm so that a police officer at a distance may be advised that a message is being received. In certain cases it is desirable to provide arrangements whereby the broadcast headquarters will know whether the message is received at each point to which it was transmitted; then an acknowledgment signal is arranged so that after each message is transmitted, the ringing of a bell on the receiving printer indicates that the transmitting station requests an acknowledgment. This can be sent back by pushing a button on the receiving machine, the acknowledgment lighting a lamp on the switchboard at headquarters.

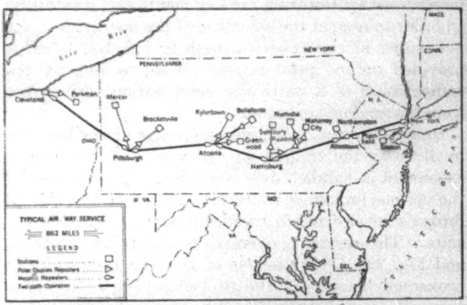

Fig. 5. Communication with planes in flight is becoming of greater importance; this is a typical private airway circuit

Other police networks are set up with all stations connected to the same circuit so that any one may send, and all of the others receive. Such a circuit connects fifteen of the principal municipalities in Connecticut, and in this way police information originating in any of these towns can be broadcast simultaneously to all of the other towns on the network.

Fig. 4 shows one of the switchboards and sending machine in a state police system.

Weather Reporting Systems for Airways. The Department of Commerce has contracted for quite a large network of private wire telegraph circuits for use in collecting and distributing weather information for use by aeroplane pilots. Weather information is collected on an hourly basis in sequence from the principal intermediate landing fields and critical points along an air route. It takes from four to five minutes to make such a weather collection over a typical air route between major landing fields. The weather information thus obtained is furnished to the air pilots before they leave the field or to pilots in the air by means of the radio telephone equipment of the Department of Commerce. Along the air route the printers are usually installed adjacent to the field in what is known as a watch-house. In addition to the service mentioned, in certain local cases private wire circuits are provided for the purpose of distributing weather information between the Weather Bureau, radio stations, airports and air transport companies' offices.

In addition to the collection of weather information the private wire circuit is used in some cases for reporting the departure, arrival, and passing of planes. Fig. 5 shows a typical airway network. The stations along the air route are usually connected in series so that each station receives the information sent from all other stations. In some cases the bell signal on the printer is used to call the attention of a particular station with which it is desired to communicate.

Fig. 6. A modern airway communication office

Manufacturing Service. Factories are generally located with regard to the availability of raw materials and the ease of transportation; executive and sales offices, on the other hand, are usually near the distributor, the exporter or the consumer. Private wire telegraph service is used extensively to provide direct-communication channels between the widely separated units of modern industrial organizations. With the aid of this service the far-flung units of this organization are kept in constant touch with each other, thereby speeding up production and improving the service rendered to their customers.

In looking forward to the future, there seems to be every indication that private wire telegraph service will continue to grow and expand, and with the requirements continually changing it is to be expected that many new and interesting developments will be applied to this service.

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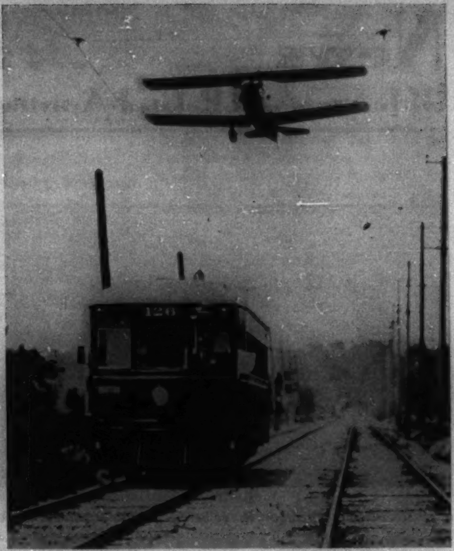
Ninety Miles an Hour in a Trolley Car!

THE fastest interurban cars in the world are leaving competing buses nearly an hour behind on the 225-mile run between Cincinnati and Toledo, though the bus route is shorter by 15 mi. By their owner, the Cincinnati and Lake Erie, these cars have been clocked at 90 mi. per hr. or better. During trials, police motorcycles were left behind, and even the aeroplane scarcely overhauled the "flying" trolley.

Unlike previous extremely fast cars, these are neither very large nor heavy. They weigh but 24 tons, seat 40 people, and are of one-man operation. Their motors rate 100 hp. each, (quadruple equipment) and in the case of the ten Westinghouse equipments, weigh complete but 2,690 lb. How extraordinarily light this is, is shown by contrast with other motors bought by this road in 1927 which weighed half again as much per horsepower. The remarkable lightness of the new motor is partly due to improved insulation, but largely to the high rotative speeds found practicable through its being wound for 300 volts. The principal advantage of the lower voltage, however, is the marked benefit to commutation. The motors are geared 26:46 on 28-in. wheels.



Outwitting the "speed cops"; electric car traveling at more than 90 mi. per hr.

Only an airplane succeeded in overhauling this new interurban electric car

In general, the experience of the Cincinnati and Lake Erie does not show that high speed offers any particular difficulties. The permanent way was put in first-class condition, with especial attention to the safe elevation of curves and the alinement of overhead, but no departure from normal standards was needed.

The interurban roads have had more than their share of post-war difficulties, but the Cincinnati and Lake Erie and its chairman, Doctor Thomas Conway, have produced substantial proof of the rewards that the industry still offers to courage and to vision.

Aeroplanes, automobiles, and yachts race for amusement, but trolley cars do not; they race strictly for revenue. So it is important to observe that in the second month of the new cars, passenger ticket receipts in three of the principal cities had increased 77 per cent. Over Labor Day, 17 of the trains had to be run in two or more sections, and in November it was understood that the cars were, as show people say, "packing them in"—and this on a road which a year ago was not embarrassed by density of traffic any more than is the average interurban road—on a road paralleled by good highways over a shorter route, by first-class buses, and by fast steam trains.

News
Of Institute and Related Activities

The new Hudson River bridge which connects upper Manhattan with the north New Jersey shore is the longest single-span structure in the world

Winter Convention Presents Attractive Program

Engineering Papers, Inspection Trips, and Entertainment of Striking Interest Assure Busy, Profitable Week

MANY excellent developments in various fields of electrical engineering will be brought out in the technical sessions at the A. I. E. E. winter convention. This meeting, which promises to equal in interest any of the past winter conventions, will be held in New York, January 26-30, with headquarters in the Engineering Societies Building. In addition to the excellent technical program there will be a number of interesting trips and good entertainment with a specially arranged program for the ladies.

TECHNICAL SESSIONS

One of the sessions that should prove of general interest is the symposium on coordination between power and communication circuits. The papers which are to be presented represent the work of a joint general committee of the National Electric Light Association and the Bell Telephone System. Each paper was prepared by a representative in the power field and a representative in the communication field jointly. The achievements obtained are a noteworthy example of cooperation between different fields of the electrical profession.

At the opening of the session R. F. Pack, vice-president and general manager of the Northern States Power Company, will make an introductory statement. Following the presentation of the papers closing remarks will be made by Bancroft Gherardi, vice-president and chief engineer of the American Telephone and Telegraph Company. The session should have a broad general appeal and the papers to be presented are not highly technical or mathematical.

Many recent developments involving design, theory, operation, and testing will be brought out in the papers which will be presented in nine other sessions in the fields of telegraphy, transportation, protective devices, power transmission, industrial power applications, electric welding, electrical machinery, and research.

EDISON MEDAL PRESENTATION

The Edison Medal will be presented to Doctor Frank Conrad for his contributions to radio broadcasting and short-wave radio transmission. Presentation will take place in the Engineering Auditorium on the evening of Wednesday, January 28.

Following the presentation ceremonies a lecture will be delivered by Doctor Karl Taylor Compton, president of Massachusetts Institute of Technology.

SMOKER

A buffet dinner and smoker will be held in the Engineering Societies Building on Tuesday evening, January 27. This informal occasion affords a splendid opportunity for members and their guests to renew old acquaintances. Plans are being made which will provide very attractive entertainment after the dinner, to be served by Louis Sherry.

DINNER DANCE

The dinner dance of the winter convention will be held in the Grand Ballroom of the Hotel Astor on the evening of Thursday, January 29. For many years this annual social event of the Institute has afforded much pleasure to all in attendance and is looked forward to from year to year by a large proportion of the membership. Tickets will be $6 per person. Reservations may be made in advance for tables seating eight people.

LADIES ENTERTAINMENT

The ladies entertainment committee is actively engaged preparing a special program which will prove very attractive for the ladies in attendance.

PROGRAM OUTLINE

MONDAY, JANUARY 26

10:00 a. m. Registration
2:00 p. m. Opening of Convention
A—Symposium on Telegraphy
8:15 p. m. B—Joint Session of Committee on Transportation and the Transportation Group of the New York Section

TUESDAY, JANUARY 27

10:00 a. m. C—Symposium on Coordination of Power and Communication Circuits
2:00 p. m. D—Session on Protective Devices
6:00 p. m. Buffet Dinner and Smoker

WEDNESDAY, JANUARY 28

10:00 a. m. E—Session on Power Transmission
2:00 p. m. Inspection Trips
Board of Director's Meeting
8:30 p. m. Edison Medal Presentation and Lecture

THURSDAY, JANUARY 29

10:00 a. m. F—Industrial Power Applications
2:00 p. m. Technical Sessions G and H
G—Transportation
H—Electric Welding
7:30 p. m. Dinner Dance

FRIDAY, JANUARY 30

10:00 a. m. I —Session on Research
2:00 p. m. J —Session on Electrical Machinery

TRIPS

On the inspection trips offered many prominent developments of interest to the electrical engineering profession may be seen:

1. The Hudson River Bridge with construction work now in progress offers an unusual opportunity for engineers to view a remarkable feat in bridge construction. The main span, 3,500 ft. in length, is the longest single span in the world and is supported between towers which rise to a height of 635 ft. above the water's surface. Four cables, each made up of 26,474 wires giving a specified minimum strength of 220,000 lb. per sq. in. and weighing 28,450 tons, support the double-deck structure. Construction work was started in May, 1927, and the initial portion consisting of four traffic lanes and two sidewalks is scheduled to be opened to traffic early in 1931. The ultimate plan provides for eight traffic lanes and two sidewalks on the upper deck with a lower deck to accommodate four rapid transit tracks. The cost of completion of the initial stage of the construction is estimated to be $60,000,000.

2. Vertical distribution in modern skyscrapers such as the Chrysler Building and the Empire State Building. The Empire State is the tallest building in the world.

3. New Eighth Avenue Subway Substations

4. Tandem-compound, 160,000-kv-a., steam-electric generating unit of the New York Edison Company.

5. Modern press installation and lighting of the new Daily News Building.

6. Modern use of light as the sole decorative agent in a large ballroom—St. George Hotel, Brooklyn, N. Y.

7. Railroad electrification as exemplified in the newly completed properties of the Delaware, Lackawanna & Western Railroad.

8. The Westinghouse Lighting Institute.

9. New York Museum of Science and Industry.

10. Roseland switching station of the Public Service Electric and Gas Company (New Jersey).

Details as to transportation tickets, etc., will be announced in the programs distributed at the convention.

REDUCED RAILROAD RATES

Under the certificate plan reduced railroad rates will be available to members and guests who attend the convention; only half fare need be paid on a return trip over the same route, provided a total of at least 150 certificates are deposited at the registration desk. Rates apply to all who attend the convention and to dependent members of their families. Each member or guest should obtain a certificate when purchasing his one-way ticket to New York, explaining to the ticket agent that he wishes the certificate authorized by the passenger associations for the winter convention of the American Institute of Electrical Engineers.

On arriving at the convention the certificate should be deposited at the registration desk. There it will be held for validation by a railroad representative and if 150 or more certificates are validated, these certificates will be returned to the owners. By presenting the validated certificate when purchasing a return ticket, only half fare will be charged. Local ticket agents should be consulted regarding conditions affecting this plan, as it applies only within certain dates, depending upon the territory. *Everyone* whose one-way fare is more than 66 cents *should get a certificate* whether or not he intends to use it. *By neglecting to do so others may be deprived of considerable saving.*

REGISTER IN ADVANCE

Each member should register in advance by mail, thus permitting the committee in charge to have the badges ready, resulting in a considerable saving of time and congestion at the registration desk.

COMMITTEES

The 1931 winter convention committee is constituted as follows: H. P. Charlesworth, Chairman; J. B. Bassett, C. R. Jones, H. A. Kidder, G. L. Knight, A. E. Knowlton, E. B. Meyer, C. E. Stephens and R. H. Tapscott.

Chairmen of subcommittees are, respectively: J. B. Bassett, convention executive committee; W. R. Smith, inspection trips; E. J. Johnson, dinner dance; G. W. E. Draper, smoker; and Mrs. E. B. Meyer, ladies entertainment.

HOTEL RESERVATIONS

Reservations for hotel accommodations should be made by writing directly to one of the hotels listed in the mailed announcement of this convention.

Newly electrified section of Lackawanna suburban lines serving New York City

Technical Program

January 26—2:00 p. m.

Opening of Convention

Remarks by President William S. Lee.

Statement by A. E. Knowlton, chairman, meetings and papers committee.

A—Symposium on Telegraphy

Presiding officer: H. S. Osborne, vice-chairman, of the committee on communication.

The Newfoundland-Azores High-Speed Duplex Cable, by J. W. Milnor, C. H. Cramer, W. D. Cannon, and J. A. Randall, Western Union Telegraph Company.

Submarine Cable Telegraphy; Influence of Interference, by J. W. Milnor, Western Union Telegraph Company.

Telegraph Transmission Testing Machines, by F. B. Bramhall, Western Union Telegraph Company.

A Printing Telegraph Concentrator, by W. B. Blanton, Western Union Telegraph Company.

Modern Practises in Private Wire Telegraph Service, by R. E. Pierce, American Telephone and Telegraph Company.

January 26—8:15 p. m.

B—Joint Session on Transportation

The New York Section's Transportation Group and the A. I. E. E. Committee on Transportation jointly participate in this session.

January 27—10:00 a. m.

C—Symposium on Inductive Coordination

Presiding officer: A. E. Knowlton, chairman of the meetings and papers committee.

Introductory statement by R. F. Pack, vice-president and general manager of the Northern States Power Company.

Trends in Telephone and Power Practise as Affecting Coordination, by W. H. Harrison, American Telephone and Telegraph Company, and A. E. Silver, Electric Bond and Share Company.

Status of Joint Development and Research on Noise-Frequency Induction, by O. B. Blackwell, American Telephone and Telegraph Company, and H. L. Wills, Georgia Power Company.

Status of Joint Development and Research on Low-Frequency Induction, by R. N. Conwell, Public Service Electric and Gas Company, and H. S. Warren, American Telephone and Telegraph Company.

Status of Cooperative Work on Joint Use of Poles, by J. C. Martin, Midwest Utilities Company, and H. L. Huber, American Telephone and Telegraph Company.

Closing statement by Bancroft Gherardi, vice-president and chief engineer of the American Telephone and Telegraph Company.

January 27—2:00 p. m.

D—Session on Protective Devices

Presiding officer: Raymond Bailey, chairman of the committee on protective devices.

An Experimental Lightning Protector for Insulators, by J. J. Torok, Westinghouse Electric & Manufacturing Company.

Field Tests on Thyrite Lightning Arresters Using Artificial Lightning of 1,500,000 Volts, by K. B. McEachron and E. J. Wade, General Electric Company.

Series Resistance Method of Increasing Transient Stability Limit, by R. C. Bergvall, Westinghouse Electric & Manufacturing Company.

Trend in Development of Modern Circuit Interrupters, by J. B. MacNeill, Westinghouse Electric & Manufacturing Company.

Philo 1930 Oil Circuit Breaker Tests (aims, set-up and results from a system and operating point of view), by Philip Sporn and H. P. St. Clair, American Gas and Electric Company.

The Oil-Blast Circuit Breaker, by D. C. Prince and W. F. Skeats, General Electric Company.

Field Tests on Standard and Oil Blast Explosion Chamber Oil Circuit Breakers, by R. M. Spurck and H. E. Strang, General Electric Company.

January 28—10:00 a. m.

E—Session on Power Transmission

Presiding officer: P. H. Chase, chairman of the committee on power transmission and distribution.

Traveling Waves on Transmission Systems, by L. V. Bewley, General Electric Company.

Impulse Tests on Substations, by A. S. Brookes and R. N. Southgate, Public Service Electric and Gas Company, and W. G. Roman and E. R. Whitehead, Westinghouse Electric & Manufacturing Company.

Lightning Investigation on a Wood-Pole Transmission Line, by J. J. Torok, Westinghouse Electric & Manufacturing Company, and R. R. Pittman, Arkansas Power and Light Company.

1929 Lightning Experience on the 132-Kv. Transmission Lines of the American Gas and Electric Company, by Philip Sporn, American Gas and Electric Company.

Attenuation and Successive Reflections of Traveling Waves, by James C. Dowell, General Electric Company.

January 29—10:00 a. m.

F—Session on Industrial Power Applications

Presiding officer: C. W. Drake, chairman of the committee on general power applications.

Electron Tubes in Industry, by W. R. King, General Electric Company.

Automatic Regulators in Industry, by J. H. Ashbaugh, Westinghouse Electric & Manufacturing Company.

Electrical Distribution Systems for Industrial Plants, by W. J. McClain and Louis T. Klauder, consulting engineers.

The Synchronous Motor with Phase-Connected Damper Winding as a Drive for High-Torque Loads, by M. A. Hyde, Jr., Westinghouse Electric & Manufacturing Company.

The Design and Application of Synchronous Motors to Meet Special Requirements, by D. W. McLenegan and A. G. Ferriss, General Electric Company.

Weather Making—A Public Service and a New User of Power, by D. C. Lindsay, Carrier Engineering Corporation.

January 29—2:00 p. m.

G—Session on Transportation

Presiding officer: Sidney Withington, chairman of the committee on transportation.

Lackawanna Suburban Electrification, by E. L. Moreland, Jackson and Moreland, Engineers.

Motive Power for Suburban Electrification, by Charles Kerr, Jr., Westinghouse Electric & Manufacturing Company.

Transverse Fissure Detector Car, by H. C. Drake, Sperry Products, Inc.

Inclined Catenary Calculations, by B. M. Pickens, Westinghouse Electric & Manufacturing Company.

Design of Catenary System for Cleveland Union Terminal, by N. F. Clement and E. E. Richards, Cleveland Union Terminals Company.

January 29—2:00 p. m.

H—Session on Electric Welding

Presiding officer: P. P. Alexander, chairman of the committee on electric welding.

Some Experiments with Arcs between Metal Electrodes, by G. M. Shrum and H. G. Wiest, Jr., General Electric Company.

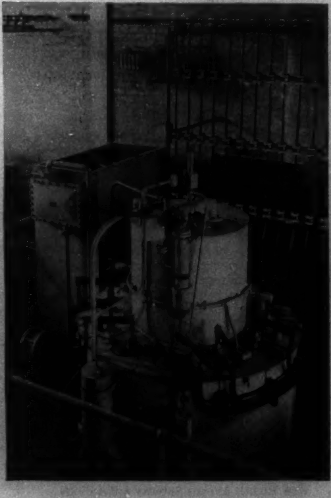
An Improved Arc-Welding Generator, by J. H. Blankenbuehler, Westinghouse Electric & Manufacturing Company.

The Neutralized Welder—a Means of Controlling Transients, by F. Creedy, Lehigh University.

A System for D-C. Arc Welding, by S. R. Bergman, General Electric Company.

Resistance Welding of Motor Frames, by Malcolm Thomson, General Electric Company.

Electric Resistance Brazing, by Samuel Martin, Jr., General Electric Company.



One of the 3,000-volt 3,000-kw. mercury arc rectifiers serving the new Lackawanna electrification

January 30—10:00 a. m.

I—Session on Research

Presiding officer: L. W. Chubb, chairman of the committee on research.

Some Electrical Characteristics of Cable Oils, by H. H. Race, General Electric Company.

The Conductivity of Insulating Oils—II, by J. B. Whitehead, Johns Hopkins University.

Fundamental Properties of Impregnated Paper, by J. B. Whitehead and W. B. Kouwenhoven, Johns Hopkins University.

Traffic Control by Light Beams, by R. C. Hitchcock, Westinghouse Electric & Manufacturing Company.

Commutation and Current Collection in Hydrogen, by R. M. Baker, Westinghouse Electric & Manufacturing Company.

The Helical Groove, by G. M. Little, Westinghouse Electric & Manufacturing Company.

Studies in Non-Linear Circuits, by C. G. Suits, General Electric Company.

January 30—2:00 p. m.

J—Session on Electrical Machinery

Presiding officer: P. L. Alger, chairman of the committee on electrical machinery.

Mercury Arc Rectifier Research, by A. W. Hull and H. D. Brown, General Electric Company.

Effect of Transient Voltages on Power Transformer Design—III, by K. K. Palueff, General Electric Company.

Stationary Flow of Heat in Large Turbine Generators, by C. Richard Soderberg, Westinghouse Electric & Manufacturing Company.

Induction-Motor Slot Combinations, by Gabriel Kron, United Research Corporation.

The Pulling into Step of a Salient-Pole Synchronous Motor, by H. E. Edgerton and Paul Fourmarier, Massachusetts Institute of Technology.

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Professional Committee Appointed to Study Engineer Licensing

To provide for closer cooperation of the Institute with the American Engineering Council in all matters connected with the improvement of the general status of the engineering profession, President Schuchardt was, in March 1929, authorized by the Board of Directors to appoint a representative to serve on the Council's committee on engineering and allied technical professions, with the understanding that this representative would become chairman of an Institute committee if it later became desirable to establish a separate committee. H. A. Kidder, superintendent of motive power, Interborough Rapid Transit Co., New York, was appointed the A. I. E. E. representative.

The Board of Directors, in August 1929, authorized the president to appoint a committee on the engineering profession to consider various matters affecting the status of the engineering profession, to cooperate with the American Engineering Council committee on engineering and allied technical professions, and to assume the duties of the A. I. E. E. committee on licensing of engineers which was, at the same time, discontinued. To serve with Chairman Kidder, President Smith appointed T. F. Barton, H. P. Charlesworth, and John C. Parker.

President Lee reappointed the four named above for the present administrative year, and, in accordance with authority granted by the Board of Directors in October 1930, has enlarged the committee to include the membership given below:

H. A. Kidder, (Chairman), supt. of motive power, Interborough Rapid Transit Co., 600 West 59th St., New York, N. Y.

J. P. Alexander, Boston manager, Westinghouse Elec. & Mfg. Co., 10 High St., Boston, Mass.

T. F. Barton, district engineer, General Electric Co., 120 Broadway, New York, N. Y.

B. M. Brigman, dean, Speed Scientific School, University of Louisville, Louisville, Ky.

H. P. Charlesworth, vice-president, Bell Telephone Laboratories, Inc., 463 West St., New York, N. Y.

L. F. Leurey, consulting electrical engineer, 58 Sutter St., San Francisco, Calif.

L. W. Morrow, editor, *Electrical World*, Tenth Ave. at 36th St., New York, N. Y.

John C. Parker, vice-president in charge of engineering, Brooklyn Edison Co., Inc., 380 Pearl St., Brooklyn, N. Y.

John R. Price, professor of electrical engineering, University of Wisconsin, Madison, Wis.

Herbert S. Sands, consulting engineer, 1115 First National Bank Building, Denver, Colo.

Maurice R. Scharff, consulting engineer, Main & Co., accountants and auditors, First National Bank Building, Pittsburgh, Pa.

H. H. Schoolfield, chief engineer, Pacific Power & Light Co., 607 Public Service Bldg., Portland, Oregon

W. I. Slichter, professor of electrical engineering, Columbia University, New York, N. Y.

J. B. Thomas, vice-president, Electric Service Co., Fort Worth, Texas

Although this committee has several very important fields of activity, it is at present devoting its principal efforts to cooperation with other organizations in the development of suitable provisions for the licensing of engineers. Through this committee and its close cooperation with the American Engineering Council committee named above, the Institute is in position to participate actively in efforts to solve problems affecting the status of the engineering profession.

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A. I. E. E. Nominating Committee Announces Official Candidates for 1931

A COMPLETE official ticket of candidates for the Institute offices that will become vacant August 1, 1931, was selected by the national nominating committee which met at Institute headquarters, New York, December 5, 1930. This committee consists of fifteen members, one selected by the executive committee of each of the ten geographical districts, and the remaining five elected by the board of directors from its own membership.

The following members of the committee were present: W. L. Amos, Toronto, Ont.; K. A. Auty, Chicago, Ill.; H. V. Carpenter, Pullman, Wash.; H. P. Charlesworth, New York, N. Y.; A. B. Cooper, Toronto, Ont.; Herbert S. Evans, Boulder, Colo; E. A. Hester, Pittsburgh, Pa. (alternate for E. C. Stone of Pittsburgh); H. A. Kidder, New York, N. Y.; E. B. Meyer, Newark, N. J.; J. S. Palmer, Kansas City, Mo.; W. S. Rodman, Charlottesville, Va. (alternate for E. D. Wood, of Louisville, Ky.); Harold B. Smith, Worcester, Mass.; C. E. Stephens, New York, N. Y.; R. G. Warner, New Haven, Conn.; W. L. Winter, San Francisco, Calif.; and F. L. Hutchinson, New York, N. Y., Secretary of the Committee. Past-president Harold B. Smith was elected chairman of the Committee.

The following is a list of the official candidates as selected by the committee:

For President

Charles E. Skinner, Assistant Director of Engineering, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

For Vice-Presidents

Middle Eastern District: W. B. Kouwenhoven, Professor of Electrical Engineering and Assistant Dean, School of Engineering, Johns Hopkins University, Baltimore, Maryland.

Southern District: W. E. Freeman, head, Department of Electrical Engineering, Assistant

Dean of College of Engineering, University of Kentucky, Lexington, Kentucky.

North Central District: Paul H. Patton, Telephone Engineering, Northwestern Bell Telephone Company, Omaha, Nebraska.

Pacific District: A. W. Copley, Engineering Manager, Pacific Coast District, Westinghouse Electric and Manufacturing Company, San Francisco, California.

Canada District: L. B. Chubbuck, Switching Equipment Engineer, Canadian Westinghouse Company, Ltd., Hamilton, Ont., Canada.

For Directors

L. W. Chubb, Director of Westinghouse Research Laboratories, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

B. D. Hull, Engineer, Southwestern Bell Telephone Company, Dallas, Texas.

H. R. Woodrow, Electrical Engineer, Brooklyn Edison Company, Brooklyn, New York.

For National Treasurer

W. I. Slichter, Professor of Electrical Engineering, Columbia University, New York, N. Y.

The Constitution and By-laws of the Institute provide that the nominations made by the national nominating committee shall be published in the January issue of the Institute Journal. Provision is made for independent nominations as indicated in the following excerpts from the Constitution and By-laws:

Constitution

Sec. 31. Independent nominations may be made by a petition of twenty-five (25) or more members sent to the National Secretary when and as provided in the By-Laws; such petitions for the nomination of Vice-Presidents shall be signed only by members within the District concerned.

By-Laws

Sec. 23. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with Article VI, Section 31 (Constitution), must be received by the Secretary of the National Nominating Committee not later than February 15 of each year, to be placed before that Committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the National Nominating Committee in accordance with Article VI of the Constitution and sent by the National Secretary to all qualified voters during the first week in March of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

National Nominating Committee
(*Signed*) By F. L. Hutchinson,
Secretary.

C. E. Skinner

Charles Edward Skinner, assistant director of engineering for the Westinghouse Electric & Manufacturing Co., a manager of the Institute (1915-19) and one of its vice-presidents (1919-20), was born on a farm near Redfield, Ohio, May 30, 1865. He was educated at Ohio University and Ohio State University, being graduated from the latter with an M. E. degree with the class of 1890. He worked his way through the university, partly as a helper at the Ohio Experimental Station Dairy and partly as a machinist in the university shops. In August, after graduating in June, he joined the organization of the Westinghouse Electric & Manufacturing Company as a machinist in charge of the manufacture of railway controllers. Early in 1891 he was put in charge of all insulation design, as well as testing. In addition to the insulation work, he took up magnetic testing and the development of magnetic materials in 1892, and retained charge of this work for many years.

In 1906 Dr. Skinner organized for the Westinghouse company the research division of the engineering department, and was responsible for the organization and equipment of the chemical, physical and process laboratories, as well as the high-tension test laboratory.

Through his efforts a laboratory for more fundamental research was determined upon in 1915 and he had charge of the building, equipping, and organization of the personnel of this laboratory. In 1920 he was made manager of the research department, taking direct and individual charge of the research laboratory for the next two years. In 1922 he was made assistant director of engineering.

Dr. Skinner went to Brussels in 1906 as American representative of the International Association for Testing Materials. In 1915 he was a special delegate from the A. I. E. E. to confer with the British Engineering Standards Committee. In 1920 he was chairman of the American Delegation to the Brussels meeting of the International Electrotechnical Commission, and held a similar position at the meeting of that commission in Geneva, Switzerland, in 1922. He was a member of the American delegation to the International Electrotechnical Commission meeting in London in 1924, The Hague in 1925, New York in 1926, and Bellagio in 1927. He was a delegate to the World Power Conference in London in 1924.

Dr. Skinner was chairman of the American Engineering Standards Committee the years of 1925, 1926, and 1927. He was elected chairman of the committee for the organization of the International Standards Association and represented the United States at the London conference of the I. S. A. in 1926.

Dr. Skinner was a member of the Engineering Council throughout its life, and is a member of the American Engineering Council, its successor. He was chairman of a special committee appointed by the Electrical Manufacturers Council, at the request of Herbert Hoover, then Secretary of Commerce, to work with the Department of Commerce and Bureau of Standards. He has been a member of the standards committee of the Institute for many years. As past chairman of the American Engineering Standards Committee he becomes a member of the board of directors of the American Standards Association.

Dr. Skinner is a Fellow of the American Institute of Electrical Engineers, member of the Franklin Institute, American Society for Testing Materials, Fellow of the American Association for the Advancement of Science, member of the American Society of Mechanical Engineers, member of the Engineers' Society of Western Pennsylvania, member of the National Electrical Manufacturers Association, the American Physical Society, the American Electrochemical Society, the Philosophical Society of Pittsburgh, the Engineers' Club of New York, the United States committee of the International Electrotechnical Commission, and the University Club of Pittsburgh. He was appointed a delegate to the International Engineering Congress held in Japan in October, 1929, acting as chairman of the American Electrochemical Society's delegation and a member of the American Standards Association's delegation to the congress. In 1927 he received the honorary degree of Doctor of Science from Ohio University.

In addition to those already mentioned Mr. Skinner has served on the following committees of the Institute: Edison medal, executive, public policy, principles of professional conduct, meetings and papers, research, electrical machinery, educational, and electrophysics.

W. B. Kouwenhoven

William Bennett Kouwenhoven was born at Brooklyn, N. Y., January 13, 1886. He received his early education at the Polytechnic Institute of Brooklyn and was graduated with the Degree of E. E. *cum laude* in 1906 and a year later received the degree of M. E. from the same institution. Early educational experience was obtained acting as instructor in electrical engineering at the Polytechnic Institute of Brooklyn for four years subsequent to his graduation. The next three years were devoted to study in Germany under Professor Arnold at the Karlsruhe Technische Hochschule, Baden, Germany, where the Degree of Doktor Ingenieur *magna cum* was conferred on him in 1913.

During the course of Prof. Kouwenhoven's professional career, he has been known to be an able educator, diligent research worker and a very capable engineer. In addition to the foregoing educational experience, he served for a year as instructor in electrical engineering at Washington University and in the year 1914 was appointed an instructor in electrical engineering at Johns Hopkins University and to date is connected with the latter institution. His progress was rapid and during the year 1917 he was promoted to the rank of associate in electrical engineering, in 1919 he was promoted again, to the rank of associate professor, and in 1930 he was made professor of electrical engineering and assistant dean of the engineering school.

Professor Kouwenhoven was in charge of the electrical engineering department at Johns Hopkins University and acted as instructor in the Reserve Officers Training Corps unit and held the rank of Captain during the war. He served part-time acting as a consulting electrical engineer at the Bureau of Standards.

From 1919 to 1920, while on leave from Johns Hopkins University, he was master engineer in the employ of the Winchester Repeating Arms Company and in charge of the installation of a plant for the manufacture of batteries and flashlights.

Professor Kouwenhoven has been very active in the Institute and other engineering societies. He became an Associate of the Institute in 1906 and was transferred to the grade of Member in 1922. He has been a member of the following Institute committees: communication, electrophysics, instruments and measurements, Sections, and the committee on coordination of institute activities. For the past three years he served as chairman of the sections committee and at present he is chairman of the Baltimore Section.

In addition to his Institute activities, many noteworthy publications, too numerous to enumerate, along research lines and on the subject of instruments and measurements, have been credited to his name. Professor Kouwenhoven is a member of the A. S. T. M. and has served as vice-chairman of the committee on magnetic testing. He is also a member of the Johns Hopkins Club and the Baltimore Engineers Club.

W. E. Freeman

William Edward Freeman was born in Fayette County, Ky., September 25, 1880. After obtaining his early education in the schools of Fayette County he attended Transylvania College and received his A. B. Degree in 1901. Technical education was obtained at the University of Kentucky, where he received the degree of B. M. E. in 1904 and later, in the year 1912, an E. E. degree was conferred on him.

Additional technical training by taking the apprentice course while in the employ of the Western Electric Company was obtained after he had received his B. M. E. degree from the University of Kentucky. The first years of his experience were obtained in the shops and the drafting department at the Chicago plant, which were followed by five and one-half years work on engineering telephone apparatus design in Chicago and in the Bell Laboratories at New York. With his good technical background and very capable manner, a number of pieces of communication apparatus were developed by Mr. Freeman during the course of his work.

In 1911 he left the engineering department of the Western Electric Company to take a position as head of the electrical engineering department at the University of Kentucky. There he was known to be a capable educator and all who had contact with him, both students and associates, benefited by this contact and his friendship. From May, 1920, to August, 1921, he supervised commercial training with the Westinghouse Electric & Manufacturing Company and during the following year acted as dean of the Engineering college at the University of Kentucky. In 1922 he was made assistant dean of the college of engineering and head of the department of electrical engineering at that university and to date is affiliated with the same institution in the same capacities.

Professor Freeman became an Associate of the Institute in 1911 and was transferred to the grade of Member in 1926, and at present he is the Branch counselor at the University of Kentucky. He is a member of the S. P. E. E. and a past-president of its Kentucky Section, a member of Kappa Alpha, Tau Beta Pi, Lamp and Cross, Masons, and Rotary Club. He is now president of the Lexington Rotary Club.

P. H. Patton

Paul Harsha Patton was born October 3, 1873, at Harshaville, Ohio. His early education was obtained at the schools in Denver and through his perseverance and initiative his technical aspect was broadened by intensive study and reading, a large part of which was night work.

Broad and varied experience was obtained in the communication field and Mr. Patton has devoted many years of work in the testing, installation, operating and management of communication companies. His career began as a telephone installer and test man in Denver in the year 1891, followed by ten years of maintenance and installation experience of multiple switchboards. Part of the time was devoted to lighting and power systems of central offices, toll switching, party line ringing and simplex telegraph and phantom equipment. In 1903 he served as superintendent of the fire and police telegraph systems and as chief inspector for enforcement of the National Electric Code, as well as supervising street lighting in the city of Omaha. During the following year he served as general superintendent of the U. S. Telephone and Telegraph Company, Waterloo, Iowa.

In 1905 he became general equipment foreman of the Nebraska Telephone Company and later was appraisal engineer, serving on the Nebraska State Railway Communication Committee for the Development of Telephone Plant Cost Units. In 1909 he became division engineer in responsible charge of engineering plans, specifications and estimates for all types of telephone plants. He was a member and treasurer of the Omaha and Council Bluffs electrolysis survey committee, a director, vice-president and president of the Omaha Technical Club, as well as a member and secretary of the Nebraska Joint Committee on Physical Relations between Electrical Supply and Signal Lines.

Mr. Patton was a member of the organization committee of the Engineers' Club of Omaha when it was organized in 1923, and has been active in the work of the club since that time, serving it in the capacities of member, director, treasurer, and president.

Mr. Patton became an Associate of the Institute in 1918 and was transferred to the grade of Member in 1925. He was a member of the formation committee for the organization of the Nebraska Section of the A. I. E. E. His long, continuous service with the telephone company, together with his joint work and many other activities, has made him a prominent figure in the communication field.

A. W. Copley

Almon Warren Copley was born in Clay Center, Kansas, January 13, 1883. Immediately after completing his electrical engineering course at the University of Kansas he entered the employ of the Westinghouse Electric & Manufacturing Company as an engineering apprentice at East Pittsburgh, Pa., and he has been in the service of that company continuously since that time.

During the course of his professional career, Mr. Copley obtained broad engineering experience. In particular, his prominent work in power transmission and inductive interference in connection with railway electrification has made him one of the recognized leaders in this subject among the engineers of the country. His other experiences consisted chiefly of designing instruments, watthour meters, relays and other similar devices. In 1913 he was in charge of designing automobile starting, lighting, and ignition equipment.

Because of his excellent character and ability, his advancement in the engineering field was unusually rapid. In 1915 he became general engineer, dealing particularly with special problems on railway electrification and general power and distribution systems. In 1921 he was made general engineer for the Pacific Coast and in 1925 he became manager of the engineering division of the San Francisco Office, dealing with engineering in all classes of electric apparatus. In 1928, upon the formation of the Pacific Coast district of the company, he was made engineering manager for the district.

Mr. Copley became an Associate member of the Institute in 1904 and was transferred to the grade of Fellow in 1926. He has ably served on the communication committee as well as on the committee on power transmission and distribution. He has been active in Institute affairs and is well known to the membership. In addition to his Institute activities he is also a member of the Pacific Coast Electrical Association, the Engineers' Club of San Francisco, and the University Club of Pittsburgh.

L. B. Chubbuck

Leonard Burrows Chubbuck was born in Ottawa, Canada, and received his college education at the University of Toronto. He took his B. A. Sc. degree in 1900 and E. E. degree shortly afterward.

Immediately after graduation he entered the employ of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, first in the drafting office and later in the power division of the engineering department. His work included switching equipment design, starting from the early days of air and oil circuit breakers.

In 1909, after nine years' experience with the Westinghouse Electric & Manufacturing Company he was transferred to the Canadian Westinghouse Company at Hamilton, Ontario, where he has been in charge of the engineering department section handling switching equipment, control, circuit breakers, etc. His first work in Canada comprised the Westinghouse switching equipment for the first stations of the Ontario Hydro Electric Commission when 110,000-volt equipment was designed and installed with very great respect. Since that time Mr. Chubbuck has been intimately connected with the switching equipment design of most of the later large hydroelectric plants throughout Canada. He has taken out various patents on disconnecting switches, etc.

Mr. Chubbuck was an Associate of the Institute for the periods 1902-1909 and 1918-1926 at which time he was transferred to the grade of Member. He has served as chairman of the Toronto Section, was Section delegate to the Chicago and to the White Sulphur Springs conventions of the A. I. E. E. and was a member for some years of the committee on protective devices.

Various engineering articles by Mr. Chubbuck have been published in the *Electric Journal*, *Electrical News*, etc., and he has lectured before the Engineering Institute of Canada, Canadian Electrical Association and Toronto Section of the A. I. E. E. He is much interested in sports and is a past president of the Burlington and of the Hamilton Tennis Clubs.

L. W. Chubb

L. Warrington Chubb, son of the late Col. Chas. St. J. Chubb, was born in Fort Yates, Dakota, on October 22, 1882. He obtained his common school education at Cheyenne, Wyoming, and Columbus, Ohio. In 1901, he entered Ohio State University and four years later was graduated with the degree of M. E. in E. E. In 1905, he entered the employ of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, as an engineering apprentice. In 1909, he was engaged in the development and application of magnetic materials. Before the organization of an isolated research department at the Westinghouse company he had charge of advance development work on electrotechnical problems and new developments.

Mr. Chubb has been very active in standardization, both national and international, and in committee work of the leading technical societies. Twice he has been sent to London and Brussels as a delegate of the International Electrotechnical Commission. His wide experience in many pioneer fields of development work has resulted in his being awarded about two hundred patents in electrical, mechanical, chemical and electrochemical and welding fields, and for various types of instruments.

In 1920, when the Westinghouse company organized its radio engineering department, Mr. Chubb was appointed manager of that department. He continued in that capacity until Jan. 1, 1930, when the radio activities of the Westinghouse and General Electric companies and the Radio Corporation of America were consolidated and concentrated at Camden, New Jersey, at which time he was appointed assistant vice-president of engineering. In June, 1930, he returned to East Pittsburgh as Director of the Westinghouse Research Laboratories.

He has been active in the Institute for more than twenty years and presented numerous papers before its meetings. He also is a member of the National Electric Light Association, American Railway Association, International Electrotechnical Commission, American Standards Association, Illuminating Engineering Society, American Association for the Advancement of Science, American Physical Society, and the Franklin Institute of Pennsylvania.

B. D. HULL

BLAKE D. HULL was born in Galesburg, Michigan, September 12, 1882, and moved to Kansas at an early age. He received his grade and preparatory education at Delphos, Kansas and graduated from the University of Kansas in 1905 with the degree of B. S. in Electrical Engineering. Since that date he has been in the employ of the Southwestern Bell Telephone Company in various branches of engineering work. At the present time he is chief engineer for that company for the state of Texas. He is past vice-president of the seventh geographical district of the Institute. He is first vice-president of the Dallas Technical Club and President of the Dallas Electrical Club. He is a member of the Institute of Radio Engineers. In addition to his business and technical activities he is a member of the Dallas Country Club, a Mason, and a member of the diaconal of the Highland Park Presbyterian Church.

H. R. WOODROW

HARRY ROY WOODROW was born in Luverne, Minnesota, April 15, 1887. After finishing his elementary school training in Des Moines, Iowa, he entered Drake University and graduated with the degree of B. S. in 1909. He continued his education at the University of Illinois under a scholarship and received the degree of M. S. with physics as major in 1911.

Mr. Woodrow joined the electrical engineering staff of The New York Edison Company in 1911 and continued his work with that organization until 1920, having advanced during the period to the position of assistant electrical engineer. During 1921 and 1922 he was in engineering work with Stone & Webster, Inc., and the Westinghouse Electric & Manufacturing Company.

During 1922 Mr. Woodrow joined the staff of the Brooklyn Edison Company in the position of assistant electrical engineer and still is with that organization, now occupying the position of electrical engineer.

Mr. Woodrow is a Fellow of the Institute and a member of the National Electric Light Association and has held the following positions in the engineering activity of these two organizations:

Chairman of the protective devices committee, A. I. E. E., 1921-25; chairman of the committee on transmission and distribution, A. I. E. E., 1928-30; chairman of the electrical apparatus committee, N. E. L. A., 1927; member of the executive committee of the Engineering Section, N. E. L. A., 1928-29; chairman of the sectional committee on lightning arresters, American Standards Committee, 1924; member of the committee on electricity distribution and use, Assoc. of Edison Illuminating Companies, 1924-25; member of the committee on electric switching and switchgear, Assoc. of Edison Illuminating Companies, 1929-30.

Mr. Woodrow holds a number of patents on electrical connections and devices. He is a member of Phi Beta Kappa, Sigma Psi and Tau Psi fraternities and a member of the Engineers Club of New York and the Crescent Club of Brooklyn.

WALTER I. SLICHTER

WALTER IRVINE SLICHTER was born in St. Paul, Minnesota, May 7, 1873, and was graduated at Columbia University in 1896 with an E. E. degree.

He entered the employ of the General Electric Company as a student in July, 1896, and the following year was transferred to the office of Dr. C. P. Steinmetz, where he was engaged for a year in carrying on experimental work, tests and calculations on various subjects. During the following two years, he was engaged in designing induction motors, alternators, rotary converters, transformers and special experimental apparatus. For a number of years thereafter he devoted most of his time to the design of electrical machinery and, more particularly, the equipment of electric railways.

In 1910, he was appointed professor of electrical engineering and head of that department at Columbia University, which position he still fills.

During the war he was civilian director of the Air Service school for radio officers at Columbia University. Since 1914, Professor Slichter has devoted considerable time to instruction in electrical engineering to naval officers of the postgraduate school of the U. S. Navy, who are detailed for study at Columbia University.

Professor Slichter became an associate in the Institute in 1900 and was transferred to the grade of Fellow in 1912. He was a member of the board of directors from 1918 to 1922, vice-president from 1922 and 1924, and has been an active worker upon several of the important committees of the Institute. He has been chairman of the meetings and papers committee, of the editing committee, and a member of the finance committee. He is a member of several other engineering and scientific societies, and in 1903 was president of the General Electric Engineering Society, and was instrumental in reorganizing it into the Schenectady Section of the Institute. He also served for several years as treasurer of the Society of Engineers of Eastern New York.

Professor Slichter has presented several papers and discussions upon various engineering subjects before the Institute and other societies, and has published many articles on technical subjects.

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Louisville Discussions Summarized in Review

ONLY discussion submitted in writing in accordance with A. I. E. E. rules governing it, is summarized; complete discussion, together with all papers so approved, will be published in the TRANSACTIONS. A list of papers presented was published in the November issue of the JOURNAL:

SESSION ON TRANSMISSION AND DISTRIBUTION

J. J. Torok discussed "LIGHTNING INVESTIGATION AT ALCOA, TENNESSEE." He pointed out wherein the results obtained at Alcoa, coupled with data from other investigations, aided considerably in establishing a more consistent concept of the origin and manner in which surges appear on the line. He cited that the results obtained bore strong evidence against the induced-voltage theory. Of the hundreds of strokes appearing over or near the line only one or two resulted in a surge which might be harmful in its character. Oscillograms of these surges showed them to be of long duration, 30 to several hundred microseconds instead of one or two to 15 or 20 microseconds, as was the earlier belief. Calculations made from these and other records as a basis determined the probable magnitude of induced surges to be of the order of from 100,000 to 200,000 volts, a value harmless to high-voltage transmission lines. Results bear out the prominence of the direct-strike theory with the need for adequate ground wire protection and low tower and footing resistances.

Records kept by these experimental stations in Tennessee showed that a normal switching surge will seldom exceed three times normal and only rarely rise to four times normal. Such data on switching surges are of great value in that they will indicate the minimum insulation a transmission line can have and still give good operating records.

J. B. MacNeill discussed the statement in E. E. George's paper, "Potential transformers are the best and most economical form of potential supply in the long run." He pointed out that successful operation on many large systems, including relaying, indicated the worth of bushing potential devices when used within their ratings. Low Costs and elimination of high-voltage potential transformers justify their use when possible. Mr. MacNeill explained further that recent improvements in bushing potential devices have reduced phase-angle error considerably over a wide voltage range.

SESSION ON PROTECTIVE DEVICES

A discussion submitted by Doctor Wilhelm Lampert on "THE PHYSICAL NATURE OF NEUTRAL INSTABILITY" was read by A. E. Knowlton. Doctor Lampert stated that at frequencies with ratios which compared with the impressed frequency is *not* an integer, an alternating bias is necessary. At even harmonics the ratio of which *is* an integer of the fundamental frequency a bias is not at all necessary. These cases are analyzed in his discussion.

John Auchincloss discussed the effect in practical cases of the neutral phenomena described in the papers on "Y-CONNECTED POTENTIAL TRANSFORMERS." The occurrence of the neutral phenomena described may give rise to very misleading or false conclusions in attempting to interpret certain system conditions from the readings of instruments connected to Y-connected potential transformers. These involve the phase comparison of system voltages for purposes of synchronizing across grounded Y-delta power transformer banks, and the detection of accidental grounds on isolated-neutral systems operating at voltages beyond the range of the ordinary electrostatic ground detector.

Professor Walter L. Upson discussed "THEORY OF ABNORMAL LINE-TO-NEUTRAL TRANSFORMER VOLTAGES." He commented on the different methods of attack in the three companion papers and analyzed Mr. La Pierre's equivalent-circuit phenomena. He believes Mr. La Pierre's theory is no doubt correct and that it is greatly clarified in the last section of the appendix. He calls attention to the lack of directions here which would enable one to predict the type of oscillations which might be expected. A series of actual oscillograms based upon predetermined constants and conditions would be interesting.

W. W. Edson in his discussion inquired about the effect of "NEUTRAL INSTABILITY," or the half- and double-frequency oscillations, on certain installations. One of these installations is three 8050/115-volt star-delta-connected potential transformers operating watthour and power-factor meters. Another was the same installation as above only operating directional relays instead of watthour and power-factor meters.

F. A. Hamilton's discussion of the papers by Messrs. C. T. Weller, C. W. La Pierre, A. Boyajian and O. P. McCarty was read by C. J. Schaus. In addition to the experiences with two applications of grounded-neutral potential transformers on portions of systems necessarily operated underground at certain times described in Mr. Weller's paper, Mr. Hamilton called attention to several other similar cases of the phenomena.

Discussion by J. Fallon on the Physical Nature of Neutral Instability was read by J. J. Thalheimer.

W. W. Edson discussed "POWER TRANSFORMER NOISE—ITS CHARACTERISTICS AND REDUCTION" with particular reference to installations adjacent to a building in residential districts. He suggested placing the transformers in a pit in front of the building. The noise would be reflected upward and would not even be objectionable to residents across the street.

In connection with discussion on "POWER TRANSFORMER NOISE," Sol Naiman suggested that a paper be prepared on the elimination of noise in small motors used for hospital installations.

F. W. Gay discussed "POWER TRANSFORMER NOISE" and suggested several methods for its reduction with a resulting improvement in apparatus design. One method suggests the lowering of densities at which materials are operating during light-load periods by the use of transformer windings in series during those periods, and in multiple during heavy-load periods. Another method of eliminating noise would be to fully enclose the electrical equipment in noise-proof compartments and carry off the heat at several different temperatures by using bodies of volatile fluid each separately sealed.

SESSION ON POWER GENERATION

T. E. Purcell discussed "GOVERNOR PERFORMANCE DURING SYSTEM DISTURBANCES." He cited that tests conducted under his supervision which were reported in a paper entitled "Operating Characteristics of Turbine Governors," presented at the 1930 A. I. E. E. Winter Convention, bore out the same general results as those reported in this paper.

He expressed surprise in finding out that turbines under test, overspeed enough to trip the emergency governors when loads in excess of 60 per cent of the rated capacity were dropped. He referred to recent tests on a 60,000-kw. single-cylinder turbine newly installed. The maximum load of about 70,000 kw. can be suddenly dropped by opening the generator oil circuit breaker without tripping the emergency governor.

E. E. George discussed "GOVERNOR PERFORMANCE DURING SYSTEM DISTURBANCES." He emphasized the importance of the point in the paper about getting machines back into step without taking them off the bus. This results in the saving of time required for re-synchronizing which might be excessive if there is trouble on the system.

Philip Sporn discussed "GOVERNOR PERFORMANCE DURING SYSTEM DISTURBANCES." He pointed out that during a system disturbance the amount of disturbance contributed by the governor itself toward the total disturbance cannot yet be definitely determined.

S. L. Henderson discussed "APPLICATION OF HYDROGEN COOLING TO TURBINE GENERATORS." He pointed out that there is some question whether it is necessary to build these machines explosive-proof. This question can only be answered by experience. He cited that the arrangement of coolers within the confines of the machine would be of interest as the machine is complete in itself and does not require the addition of ducts or cooler supports.

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Directors Hold December Meeting

The regular meeting of the Board of Directors of the American Institute of Electrical Engineers was held at Institute headquarters, New York, on Thursday, December 4, 1930.

There were present: President W. S. Lee, Charlotte, N. C.—Past President Harold B. Smith, Worcester, Mass.—Vice-Presidents Herbert S. Evans, Boulder, Colo.; W. S. Rodman, Charlottesville, Va.; C. E. Sisson, Toronto, Ont.; H. V. Carpenter, Pullman, Wash.; I. E. Moultrop, Boston, Mass.; H. P. Charlesworth, New York, N. Y.—Directors F. C. Hanker, East Pittsburgh, Pa.; E. B. Meyer, Newark, N. J.; J. Allen Johnson, Buffalo, N. Y.; A. M. MacCutcheon, Cleveland, Ohio; C. E. Stephens, New York, N. Y.; A. B. Cooper, Toronto, Ont.; A. E. Knowlton, New York, N. Y.—National Treasurer W. J. Slichter and National Secretary F. L. Hutchinson, New York, N. Y. Present by invitation: H. A. Kidder, New York, Chairman of the Committee on the Engineering Profession.

Reports of meetings of the Board of Examiners held October 21 and November 18 were presented and the actions taken at those meetings approved. Upon the recommendation of the Board of Examiners, the following actions were taken upon pending applications: 1029 Students were enrolled; 70 applicants were admitted to the grade of Associate; 17 applicants were elected to the grade of Member; 69 applicants were transferred to the grade of Member; 9 applicants were transferred to the grade of Fellow.

Approval by the Finance Committee, for payment, of monthly bills amounting to $26,078.21, was ratified.

A resolution was adopted setting the time and location of the 1931 Annual Meeting of the Institute; namely, Monday, June 22, at Asheville, N. C., during the Annual Summer Convention of the Institute.

Mr. William B. Jackson was reappointed a representative of the Institute on the Engineering Societies Library Board for the four-year term beginning January 1, 1931. Mr. L. T. Robinson was reappointed a representative to serve on the Standards Council of the American Standards Association for the three-year term beginning January 1, 1931, and Messrs. H. H. Henline, H. M. Hobart, and H. S. Osborne were reappointed alternates on the Standards Council for the year 1931.

Approval was given of a plan developed by a joint committee of the Founder Societies and the McGraw-Hill Book Company for the publication by the latter of a series of Engineering Societies Monographs, consisting of manuscripts worthy of publication which have been submitted to the societies but which will not be published by the societies. Messrs. E. B. Meyer and W. I. Slichter were appointed as the Institute's representatives on the Engineering Societies Monographs Committee.

Other matters were discussed, reference to which may be found in this and future issues of the JOURNAL.

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A Half Century of Electrical Engineering

In celebration of its fiftieth anniversary, the Western Society of Engineers held a meeting in Pittsburgh, Pa., November 14, at which the progress of engineering achievement during the life of the Society was the keynote of the addresses delivered.

Professor Charles F. Scott, Yale University, covered the field of electrical engineering, describing its major advances step by step, from the advent of engine power in the last century to the outstanding electrical developments of today. With the birth of engine power, the engineering spirit was awakened and in two decades the half dozen engineering schools of 1860 had increased fourscore; yet the engineers of 1880 little realized that a new power would soon be at their service.

The Edison incandescent lamp, announced in 1879, inaugurated the era of electric service which has become almost universal—a second industrial revolution. In 1886 the a-c. system of distribution, sponsored by George Westinghouse, began operation in Buffalo, and with it came the era of long distance transmission.

In the sixties the general communication system with numerous private lines connecting residences, offices, and factories, established a service for person-to-person communication carried on by messenger, printing telegraph, and delivery boy. This system was simplified by invention and about 1878 the telephone exchange was installed. Thirty years ago Marconi's three dots spanning the Atlantic heralded the wireless telegraph. Then came broadcasting. A new public service was inaugurated in the pioneer broadcasting which took place about ten years ago. Frank Conrad working with the amateurs discovered that the rejected short wave had vast superiority for long distance service; for instance, talking with Byrd at the South Pole.

One may well ponder over the question —Does electric power, or electric communication—one serving the physical, the other intellectual—make the greater contribution to our modern life?

In the advance of man, definite stages or epochs are recognized. The use of fire, the bow and arrow, the invention of pottery, the domestication of animals, the use of iron—each gave means of life on a higher plane. The outstanding factor in historic time is the production of power; in plotting a curve of human progress the long level of many centuries changes into high ground as the activities of the 19th century of steam power are reached. But they are only foothills before the rising altitude of the 20th century record. These curves of activity in a score of fields, simultaneously with the shift from muscle to manufactured power, coincide with the increasing use of power in the new ways provided by electricity.

In achievement and in anticipation, the story of electricity during the past half century illuminates the verdict of Herbert Hoover that "Electricity is the greatest tool that ever came into the hands of man."

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Treasurer Hamilton Resigns W. I. Slichter Elected

National Treasurer George A. Hamilton, because of illness, has found it necessary to resign his office. With regret, on November 25th, at a special meeting of the Executive Committee the resignation was accepted and Professor Walter I. Slichter of Columbia University was elected to fill the unexpired term ending July 31, 1931.

At a meeting of the Board of Directors held December 4, the action of the Executive Committee was ratified and the following resolution adopted:

> WHEREAS the resignation of National Treasurer George A. Hamilton, because of illness, was accepted with regret by the Executive Committee at a special meeting held at Institute headquarters on November 25, 1930, and this action has been confirmed at this meeting, be it
>
> RESOLVED that this Board, acting in behalf of the membership of the Institute, hereby places upon record its high appreciation of Mr. Hamilton's long and loyal service since 1895, as Treasurer of the Institute; also of his many and valuable contributions to the Institute as a charter member, Vice-President 1884-6, and member of the Board of Directors, Executive, Edison Medal and other committees; and extends to Mr. Hamilton its greetings and best wishes.

Memorable Meeting Held by the A. S. M. E.

So many features of the annual meeting of the American Society of Mechanical Engineers held early in December were of technical interest and stimulus that its fruitfulness will no doubt be felt well into the future. Good papers of ample scope in the fields to which they specifically applied were supplemented by the animated general discussion which always makes so strongly for constructive values. The handling of materials, railroad development, machine shop practise, gas and oil power, central station power, aeronautics, refrigeration, and American management in Europe, were a few of the subjects to which the convention gave investigation and with more than two thousand engineers in attendance one may appreciate its significance as a medium for the dissemination of a superabundance of broad and versatile information. Industrial accident prevention was supported in a symposium given under the auspices of the A. S. M. E. standing committee on safety.

In a session on hydraulics, Frank E. Bonner, executive secretary of the Federal water-power commission gave rise to such enthusiasm and support of his cause that a resolution was passed by the society's Council for the appointment of a special "Engineer's Water-Power Policy" committee, on which would serve five men chosen from the national representative bodies—two from American Engineering Council and one each from the mechanical, civil, and electrical engineers. The essence of Mr. Bonner's paper appears elsewhere in this issue.

"The Human Problem" took issue in an address delivered by Professor Elliott Dunlap Smith of Yale, at the annual dinner. It was a challenge to the engineer's unmindfulness of obligation both social and technological, and the animation with which Professor Smith delivered his speech paved the way forcefully for sessions held for the discussion of the stabilization of employment, and of economic and industrial power. A special conference assembled at the request of American Engineering Council presented Colonel Arthur S. Wood, chairman of the President Hoover Emergency Committee for Employment to sponsor industry's efforts to stabilize employment both in the past and during the present crisis. In his address he cited a paper presented in 1886 by Henry R. Towne—an epoch-making document responsible for the inauguration of an entirely new management movement in this country. The greatest hope of solution for the present crisis, Colonel Wood believes, rests with an intelligent and persistent attack of the situation by engineers and economists.

Account of the award of the John Fritz Gold Medal to Admiral David Watson Taylor, Chief Constructor of the United States Navy during the World War, and the conferring of honorary membership in the Society upon Doctor Elihu Thomson, past-president of the Institute, may be found briefly stated in another news column of this issue.

Section delegates, the representatives of localized and important society effort, were also in special convention at this last annual meeting, which has also been voted "the best."

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Illumination Commission to Meet in England

President E. C. Crittenden of the U. S. national committee of the International Commission on Illumination reports that the general outline of plans for the session to be held in Great Britain in 1931 is now practically complete. In connection with the commission's sessions there will be an international illumination congress and a tour of inspection to various cities. The whole program will fill the time from Sept. 2 to Sept. 19, 1931.

After registration in London delegates will go to Glasgow for the first session Sept. 4. Meetings will follow in Edinburgh, (Sept. 6), Sheffield, (Sept. 8), Birmingham, (Sept. 10), and finally in Cambridge, (Sept. 13-19). The dates have been chosen to bring the meetings to a close immediately before the three-day celebration of the Faraday centennial in London, which will include a meeting of the Institution of Electrical Engineers and will be followed by the annual meeting of the British Association for the Advancement of Science.

Looking forward to the 1931 sessions, the primary aim of the U. S. committee during the past year has been to arrange for creditable representation at the sessions of American interests,—developments, and opinions. The United States is particularly charged with responsibility for four very important divisions of the commission's work: (1) motor-vehicle lighting, (2) factory and school lighting, (3) aviation lighting, and (4) applied lighting practise in fields not otherwise specifically covered. The last two are new assignments, and in these there has been the keenest interest.

To provide a direct connection between the four committees in charge, a special committee has been formed under the chairmanship of A. L. Powell. This coordinating committee is to assist and advise also those who represent the United States on the 14 projects managed by other national committees, thus serving as a general clearing house for American contributions to the congress and commission sessions outside the scope of the secretariat committees.

On two important questions of standardization the assistance of this commission has been sought during the year by other international organizations. One is the problem of lamp bases and sockets; this has been before the International Electrotechnical Commission for several years.

The second question of international standardization which has been raised falls clearly within the field of the I. C. I. The International committee of weights and measures, which now has jurisdiction over international electrical units and standards, has taken up the problems of photometry also. Its advisory committee on electricity has been authorized to seek the collaboration of the I. C. I.; this action will give a new stimulus to the attempt to agree upon (1) a primary standard of light and (2) a uniform and accepted method of measuring lights of widely diverse colors.

Reverting to the matter of representation from this country at the 1931 session, it should be made clear that participation in the session and the tour of inspection is not limited to those who are now taking part in the work of the Committee. The A. I. E. E. is represented on the U. S. National Committee by A. E. Kennelly, C. O. Mailloux and Clayton H. Sharp.

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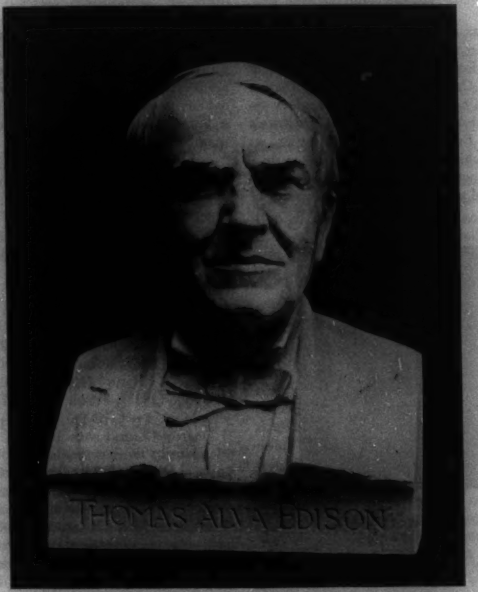
Edison Bust for Deutsches Museum



The Hall of Honor in the Deutsches Museum, Munich, shortly will receive from the United States, with the Institute and the Edison Pioneers as joint sponsors, a marble bust of heroic size of Thomas A. Edison. Formal presentation will be made in Munich by an American delegation, the date of presentation being subject to the convenience of the museum authorities.

District Prizes Awarded at Philadelphia Meeting

J. A. Noertker, of the Cincinnati Street Railway Company's engineering department, and H. F. L. J. Seyler of the Consolidated Gas Electric Light and Power Company of Baltimore, are winners respectively of the Institute's Best Paper Prize and the Initial Paper Prize awards for the year 1929. Mr. Noertker's paper was entitled *Street Railway Power Economics on the Cincinnati System*, and Mr. Seyler's, *Current Characteristics of Constant-Current Transformers During Sudden Changes of Load.* Awards were made October 14, 1930, at the Institute's Middle Eastern District Meeting at Philadelphia.

J. A. NOERTKER

Mr. Noertker is a native of Cincinnati, Ohio, and a graduate of the University of Cincinnati (1923). He entered the employ of the Cincinnati Traction Company as a cooperative student, and after graduation remained with the company in the capacity of "special engineer." In 1927 he was promoted to the position of electrical engineer of the newly organized Cincinnati Street Railway Company.

H. F. L. J. SEYLER

Mr. Seyler is a graduate of York High School, York, Pennsylvania (1923) now doing night school work at Johns Hopkins for a B. S. degree in engineering. He has traveled extensively in this country in the interest of the electric construction department of the Pennsylvania Water and Power Company. Since 1925 he has been in the electric test department of the Consolidated Gas, Electric Light and Power Company engaged in various special tests and investigations on radio interference problems, special studies on constant-current transformers, and series street-lighting circuits; also the effects of corona on fuses, and the characteristics of high-voltage fuses, disconnect switches, oil circuit breakers, etc. Most of his time is now being devoted to special oscillographic work and a generalized study of lightning on the 66-kv. ring of the Consolidated company.

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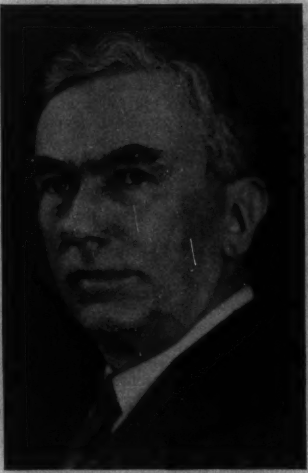
Edison Medal Awarded to Dr. Frank Conrad

"FOR his contribution to radio broadcasting and short-wave radio transmission" Doctor Frank Conrad, Pittsburgh, Pa., has been given the 1930 Edison Medal Award by the American Institute of Electrical Engineers. It is planned to present the medal to Doctor Conrad on Wednesday evening January 28, 1931, in connection with the annual Winter Convention of the Institute.

The Edison Medal was founded February 11, 1904, by associates and friends of Thomas A. Edison and is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts," by a committee consisting of twenty-four members of the Institute.

Since its establishment the medal has been awarded to the following men: Elihu Thomson (1909), Frank J. Sprague (1910), George Westinghouse (1911), William Stanley (1912), Charles F. Brush (1913), Alexander Graham Bell (1914), Nikola Tesla (1916), John J. Carty (1917), Benjamin G. Lamme (1918), W. L. R. Emmet (1919), Michael I. Pupin (1920), Cummings C. Chesney (1921), Robert A. Millikan (1922), John W. Lieb (1923), John W. Howell (1924), Harris J. Ryan (1925), William D. Coolidge (1927), Frank B. Jewett (1928), Charles F. Scott (1929).

Doctor Conrad was born in 1874 in Pittsburgh, Pennsylvania. In 1890 he entered the employ of the Westinghouse Electric and Manufacturing Company in Pittsburgh and his rise in that organization was rapid. After several years as an assistant in the shops he entered the laboratory and during the ensuing stage of his work he invented several forms of switches, lightning arresters, and breakers for use in alternating-current work. He was closely associated with, and later in entire charge of, the arc-lamp design department. This was his first engineering work. Doctor Conrad's connection with radio dates back before the days of broadcasting when he became interested as an amateur in radio reception of time signals and later in radio-telephone transmission by means of vacuum tubes. He established an amateur radio telephone station which later resulted in the development of the Westinghouse station, KDKA.



DOCTOR FRANK CONRAD

Doctor Conrad was appointed a general engineer of the Westinghouse organization in 1904 and was promoted to the position of assistant chief engineer in 1921. In 1925 he was awarded the Morris Liebmann Memorial Prize of the Institute of Radio Engineers for his early work in connection with high-frequency transmission.

He is a Fellow of the Institute of Radio Engineers, a member of the Society of

Automotive Engineers, and a member of the American Association for the Advancement of Science. He received the honorary degree of Doctor of Science in 1928 from the University of Pittsburgh.

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Conductivity of Threaded Connections

Measurements have been completed by the Bureau of Standards covering electrical resistance between nuts and bolts, using two radically different types of threads—the American National and the Dardelet—and different materials. Results showed that the contact resistance usually is less than the resistance of a one-inch length of the bolt and that under similar conditions the resistance of the Dardelet thread generally is not more than one-fourth that of the American National thread. Maximum resistances found were for steel bolts of the American National thread, in which, with a stress of 2,000 lb. per sq. in. in the bolts, (about an inch length of bolt), the resistance is about 10 microhms. Minimum stresses were found for copper bolts with Dardelet threads in which, with a stress of 6,000 lb. or more per sq. in., the resistance was approximately 0.02 microhm, equivalent to about 1/64 in. of bolt.

This subject is treated in further detail in Research Paper No. 227, Bureau of Standards.

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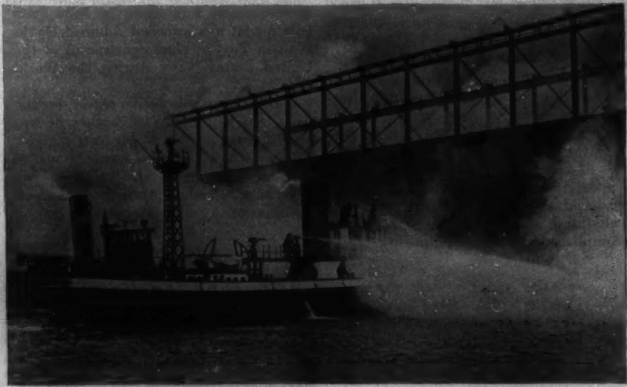
Dr. Millikan Predicts Added use of Sun's Rays

Science, instead of being even a fractional deterrant to business, as some claim, may prove on the contrary a solution whereby adjustment of present circumstances may be accomplished, is the opinion expressed by Doctor Robert A. Millikan before the second session of the Association of Life Insurance Presidents recently reported convention in New York City. Doctor Millikan's thought according to the account is to use direct sunlight instead of the stored solar energy found in coals and oils. He asserts that if it were possible for the hydrogen in seawater to be combined on the earth's surface with helium, oxygen, carbon, nitrogen, silicon, etc., energy would be released in enormous quantities with no violation of any established thermodynamic law. He sketched a future in which science will "almost indefinitely increase the satisfaction of human wants"; saying, "science creates more jobs than it destroys".

Two-Way Radio Phone Demonstrated by Fire Boat



Possibility of maintaining constant communication with shore headquarters two miles distant was demonstrated recently through the use of a two-way radio apparatus installed on the John Purroy Mitchell flagship of New York City's fire fighting fleet. This is one of the first proofs of effective use of radio communication in connection with the fighting of fires and it is expected that it may result in a saving of thousands of dollars annually. Beside doing away with the necessity of responding to false alarms the two-way system permits centralized direction of marine fire forces and greatly improves coordination with land forces.

In the apparatus used for test demonstration, transmission and reception were carried on alternately by means of a small push button on the telephone transmitter. This push-button controls relays which connect either the transmitter or the receiver with the antenna subject to the will of the operator. The Federal Radio Commission already has authorized reciprocal radio stations for this new utilization of radio facilities; the land station in New York will be designated as WCF and the station aboard the New York fire boat will be WRBE.

◆ ◆ ◆

"Cal.-Tech." to Have Astro-Physics Laboratory

A laboratory devoted to research on astronomical and allied subjects is to be built by the California Institute of Technology, Pasadena, as a part of its new 200-in. telescope observatory, to be located in the adjacent mountains. Equipment for the new astro-physics laboratory was described by Emmett M. Irwin, late of the General Electric Company, in a recent address before a Student Branch Meeting in Pasadena. Mr. Irwin now is engaged in research work at the Institute in Pasadena and is contributing much to the general design for the new laboratory and its equipment.

Two features are of particular interest to the electrical engineer; one, a coelostat tower 75 ft. high, to be used in obtaining spectrographs of the sun. The dome of this tower, holding the collecting mirrors, must of necessity rotate with the sun; it will have an independent electrical system of limited power, but maintained at an accurately constant frequency by the oscillation of a piezo-crystal suitably amplified. For precision, this idea supplants the ordinary clockwork method, which because of reverse power fed back from manually-operated mechanisms, is subject to inaccuracies.

The second unique piece of apparatus which Mr. Irwin's plans include is a 200-kw. solenoid to be used in the investigation of solar spectra under the influence of intense magnetic fields, it being supposed that sunlight reaches us at times through intervening magnetic fields in space which break up the spectrum lines into unusual components. As proposed, the coil used will be of 17-in. diameter and five or six feet high. To keep its dimensions within reason, it must be essentially a high-current instrument; leads to the solenoid will be of ¼-x 6-in. copper bars carried through a special tunnel outside the building about 200 ft., from the generator room to the tower. In a laboratory of this nature space for generator layout is limited and great care must of necessity be exercised, problems of interference being very fully debated. Synchronization of units distributed over the building with the main system will be accomplished by Selsyn equipment.

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Can Power Come from Tropic Seas?

Power stored in tropic seas is capable of operating electric generating plants of as much as 25,000-kw. capacity, according to assertion made by Professor Georges Claude, famous French scientist, in a lecture before a recent meeting of the American Society of Mechanical Engineers. Reported in the November 1, 1930, issue of *Science News Letter* is an interesting account of Professor Claude's proposal to build a power plant to utilize the hydroelectric possibilities available through the temperature differences between the surface and the deeper water of southern seas. It is asserted that so far as convertible energy is concerned a given installation could be compared with a 300-ft. waterfall.

According to Professor Claude's proposal such a plant could be located near Santiago de Cuba, and could be of sufficient capacity to meet the normal requirements of several thousands of people. Three million dollars is said to be the approximate cost of developing such a plant. This figure, although somewhat greater in proportion than that of the modern steam-electric plant, is said to compare favorably with other hydroelectric installations, all points considered.

In this process of conversion of ocean waters into usable power it is contemplated that the warm surface water would first be vaporized into steam at a very low temperature; the tepid water not being heated but merely subjected to vacuum. Steam so obtained would be passed through a turbine and thence to a condenser cooled by water drawn from a relatively great depth. Thus the cycle contemplated is similar to that of a normal steam-electric generating plant.

Fritz Gold Medal Awarded Admiral Taylor

Wednesday evening Dec. 3, 1930, at the annual dinner of the American Society of Mechanical Engineers, the John Fritz gold medal was awarded Admiral David Watson Taylor, chief constructor of the United States Navy during the World War.

During his whole active career, lasting from 1881 to Jan. 15, 1923, when he was retired from service at his own request, Admiral Taylor's record has been one of unusual achievement and value to both governmental and professional causes, both nationally and internationally.

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Biggest Radio Tube

By the grouping together of several of these huge 200,000-watt radio tubes, former Federal Radio Commissioner O. H. Caldwell (standing) now editor of *Electronics* predicts that the million-watt broadcasting station will become a reality. This giant tube has its grid as well as its plate watercooled, the operation requiring approximately 1,250 gallons of cooling water hourly.

In the hope of overcoming static and thus affording better service for millions of people, especially those located in rural districts, Mr. Caldwell, as Radio Commissioner, urged the use of high powered broadcasting stations, and toward this end the above pictured tube seems to be an important step of accomplishment.

A. S. A. Chooses Dr. Gherardi President

The election of Bancroft Gherardi to the presidency of the American Standards Association was announced at the annual meeting of the association Dec. 11, 1930. He will now assume direction of national and international standardization activities for the organization, a task involving more than 2,000 representatives of some 500 national trade, technical, and governmental bodies. Mr. Serrill's work (Mr. Gherardi's predecessor) included the completion of 46 new national standard, in mechanical, electrical, civil, chemicals mining, and woodworking fields during the past year, with a number of safety codes which are now being used by regulatory bodies, by insurance groups, and by industry in behalf of uniform methods for safeguarding the lives and health of workers.

Others taking office in the association under the coming year's elections are, Cloyd M. Chapman, engineering specialist of New York City, re-elected vice-president and chairman of the A. S. A. Standards Council, and John C. Parker, serving as vice-chairman.

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Dr. Thomson A. S. M. E. Honorary Member

Doctor Elihu Thomson, past-president and Honorary Member of the Institute and director and founder of the Thomson Laboratory of the General Electric Company at Lynn, Mass., was awarded honorary membership in the American Society of Mechanical Engineers on Dec. 2, 1930, during that society's annual meeting. The presentation was made by Dr. Ambrose Swasey of Cleveland, a past-president of the A. S. M. E.

The importance of Dr. Thomson's scientific and engineering achievements already has received recognition by representative societies of many countries in the form of medals, fellowships and official position. His conspicuous work in behalf of Institute activities is too well known to require further publicity here.

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A Tube the Equivalent $5 Billion of Radium

"Wonders of a new X-Ray machine—a 650,000-volt tube" was the subject of Dr. R. A. Millikan's talk before the Radiological Society of North America at its late meeting as reported in the daily press. The tube's potentialities in the fields of medicine, physics and engineering, the noted scientist said, are undeterminable at present.

Its rays approximate the gamma rays of radium, and what may lie ahead in its application for the penetration of metals and of non-homogeneous masses and the molecular structure of human tissues remains for the future to reveal.

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New Photoflash Lamp Makes Photography Safe

It is claimed that the dangers from flashlight powders used in photographic work have been conquered to no inconsiderable degree in the production of what will be known as "photoflash" lamp. It is a Westinghouse discovery whereby an ordinary incandescent lamp is reported to be converted into one which will produce a four-million-candlepower flash free of the danger of fire to any inflammable surroundings to which its service may be destined.

There is no smoke, no flame; a glass confines the chemical reaction and all residue. Being similar to the 100-watt household lamp, the photoflash lamp is claimed to operate on any ordinary electric light socket or even from the ordinary handflashlight battery when equipped with the household lamp socket.

Standards

Standardization Projects Reviewed

For those interested in the status of the various electrical standardization projects which are being carried on under American Standards Association procedure, there appears in the November issue of the *A. S. A. Bulletin* a detailed statement. covering 35 undertakings. The Institute is serving as sponsor or joint sponsor in 23 of these and is represented in many of the others. Copies of the bulletin may be obtained by addressing A. S. A. headquarters, 29 West 39th Street, New York, N. Y.

A. S. T. M. STANDARDS

The 1930 edition of the triennial book of A. S. T. M. standards has just been issued. It contains 430 standards adopted by the Society and is issued in two parts:—Part I—Metals—standards relating to steel, wrought iron, pig and cast iron, ferro alloys, non-ferrous metals, miscellaneous. Part II—Non-Metals—standards relating to cement, lime, gypsum, concrete and aggregates; brick, refractories and tile; preservative coatings; petroleum products and lubricants; road materials; waterproofing and roofing materials; rubber products and insulating materials; textile materials; coal, coke, timber and miscellaneous. The two volumes may be obtained at the following prices: Part I, cloth $7.50; half leather $9.00. Part II, same prices. Both parts at $14.00 and $17.00 according to binding. Address American Society of Testing Materials, 1315 Spruce St., Philadelphia, Pa.

ELECTRICAL DEFINITIONS

The Sectional Committee on Electrical Definitions of which the Institute is sole sponsor and that is engaged in what is virtually the compilation of a dictionary of American standard definitions in the electrical field, is now reaching a point in its work where results are showing. Certain of the 15 sub-groups to which the work has been allocated are furnishing reports in a status suitable for setting in type for final distribution. The work is slow because of the care with which it must be carried on and the necessity of obtaining approval of all interested bodies.

In their preliminary reports the various chairmen are confining themselves to those definitions on which there is no question. Others will follow later as difficulties are ironed out and inconsistencies eliminated. Those groups which are advanced farthest at present are, illumination, transportation, control and transmission. When the work is completed the publication containing the complete report will be of great value to the electrical industry.

Personal

F. D. NEWBURY, former manager of the power engineering department of Westinghouse at East Pittsburgh, has been appointed general manager of machinery engineering; **R. A. MCCARTY** succeeds him in the power engineering department managership.

T. A. FAWELL has made new business connections with the Marwood Company of San Francisco, which operates in six Pacific Coast cities under its various local organizations in its activities of repair and construction of motors and shop equipment.

CLAXTON A. ALLEN, formerly manager of the southwestern district of Westinghouse Electric & Manufacturing Company, was elected a commercial vice-president at a recent meeting of the company's board of directors. Mr. Allen's duties of coordination will extend to the domestic appliance division and others serving the household market, including refrigeration, radio, etc.

EVERITT W. WILSON, formerly vice-president of R. W. Hebard Co., Inc., of New York, and later foreign representative for the J. G. White Engineering Corporation of New York, now is associated with Winston Brothers Company of Minneapolis, Minn., as representative for the negotiation of contracts outside of the United States.

Obituary

WILLIAM B. CLARKSON, of the industrial control engineering department of the General Electric Company, Schenectady, and since 1919 an Associate of the Institute, died Oct. 23, 1930, at the Long Island City College Hospital, Brooklyn, N. Y., after an illness of several weeks.

He was a native of Brooklyn (December, 1892) and held two professional degrees, A. B. from Williams College in 1913 and M. E. E. from Harvard Graduate School of Engineering in 1915. His professional work with the General Electric Company originated in 1915 when he became test man in the Schenectady works; in 1917 he advanced to the position of engineer of the industrial control department of the same Company. In August of that year he received his commission as a second lieutenant of engineers, assigned to the 303d Engineers as supply officer for the 1st Battalion in British Area. He was discharged from military service in 1919 as a first lieutenant and returned to the industrial control department of the General Electric Company.

EDMUND D. MCCARTHY, president of McCarthy Brothers and Ford of Buffalo, N. Y., died suddenly Dec. 13, 1930, of heart failure.

He had been in the electrical business for more than 35 years and was prominent in the field of electrical contractors and jobbers in the State of New York. His efforts had been principally for the betterment of the electrical industry, serving as general chairman of the Electrical League of the Niagara Frontier, past-president of the Buffalo Electrical Contractors Association, and as a director of numerous companies including the Marine Trust Company, the Iroquois Share Company, and the Buffalo Chamber of Commerce. For many years he was in the New York National Guard, in which he rose to the rank of major. He joined the Institute as Associate in 1896 and also was a member of the Engineering Society of Buffalo and numerous local recreative groups including Buffalo Canoe, Buffalo Athletic, Cherry Hill, and Buffalo Country Club.

Andrew M. Hunt, consulting engineer and past member of the Institute died at Berkeley, California, Dec. 8, 1930, in his 72d year. He was a graduate of the Annapolis Naval Academy and had become prominent in both mechanical and electrical engineering fields. Upon extending his resignation from the navy, Mr. Hunt opened his own offices as consulting engineer in San Francisco, but in 1915 he came to New York to head the firm of Peyton-Hunt Company, Inc. His appointment to the Naval Consulting Board took place in 1917. Mr. Hunt was a member of the American Society of Mechanical Engineers, the American Institute of Consulting Engineers, the American Chemical Society, and numerous other technical bodies.

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the addresses as they now appear on the Institute records. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the Secretary at 33 West 39th St., New York.

All members are urged to notify Institute Headquarters promptly of any changes in mailing or business address, thus relieving the member of needless annoyance and assuring prompt delivery of Institute mail, the accuracy of our mailing records, and the elimination of unnecessary expense for postage and clerical work:

Bates, Putnam A., 117 W. 72nd St., New York, N. Y.

Cromwell, R. C., 1814 Harris Trust Bldg., Chicago, Ill.

Dawson, Leonard L., 98 Looker Ave., Springfield, N. J.

Fielding, Geo. T., General Cable Corp., Graybar Bldg., New York, N. Y.

Hursh, G. E., 345 Lenox Road, Brooklyn, N. Y.

Lieb, Adolph W., N. Y. Edison Co., 393 Seventh Ave., New York, N. Y.

Engineering Index

Engineering Index Service
29 West 39th Street, New York, N. Y.

Selected references to current electrical engineering articles from Engineering Index Service's review of some 1,800 technical periodicals.

All articles indexed are on file in the Engineering Societies Library, which will furnish photoprints of any article at a cost of 25 cents per page or make translations of foreign articles at cost.

ARCS

Carbon. A Geometrical Analysis of Open Carbon Arc Phenomena, W. Cramp and A. P. Jarvis. *Instn. Elec. Engrs.—Jl. (Lond.)*, vol. 68, no. 406, Oct. 1930, pp. 1301-1312, 11 figs. Behavior of carbon arc with resistance in parallel is developed geometrically and proved experimentally; conditions governing musical arc analysis show that musical arc, in which current oscillates about point on volt-ampere characteristic, is possible but that it is unstable; tendency for arc oscillations to grow until extinction ensues is traced; necessity for introduction of thermal term in equations.

BATTERIES

Storage. Characteristics of Secondary Batteries Under Reduced Atmospheric Pressure, S. Makio. *Electrotech. Soc. Waseda—Jl. (Tokyo)*, vol. 11, no. 10, Oct. 1930, pp. 359-364, 5 figs. Result of investigation, contrary to Dolezaleck's conclusion, shows that capacity of accumulator is increased under reduced pressure and that this increased capacity is maintained for a while, even after accumulator is brought out in ordinary atmospheric pressure, and then, gradually returns to its normal value in atmospheric pressure with repeated charges and discharges. (In English.)

BOULDER DAM PROJECT

The Boulder Canyon Project. *Eng. and Contracting*, vol. 69, no. 11, Nov. 1930, p. 398. Construction features of $165,000,000 dam and reservoir, irrigation canal, and power development by U. S. Bureau of Reclamation; Hoover dam will be about 727 ft. above foundation rock; power plant capacity will be 1,000,000 or 1,200,000 hp.; All-American canal will be 75 mi. long, and Coachella branch will be 115 mi. long; new town will be located about 6 mi. due west of dam site.

CABLES

High-Tension—Joints. Super-Tension Cable Jointing, J. Riedl and R. S. Dawson. *Elec. Engr. of Australia and New Zealand (Melbourne)*, vol. 7, no. 6, Sept. 15, 1930, pp. 205-208, 7 figs. Method adopted by Australian Siemens Concern in jointing 33-kv. cable for Municipal Council of Sydney.

Underground. 1920-1930 Report Underground Systems Committee. *Nat. Elec. Light Assn.—Reports of Committees*, for mtg. Sept. 25-27, 1930, 57 pp., 20 figs. Résumé of outstanding accomplishments of Committee for administrative year together with recommendations for future study; complete papers on Underground or Cable Distribution Systems in Outlying Territory, Requirements of Good Cable Training, Preparation of Specifications and Standards, Fault Localization in Distribution Cables, Twenty-Ampere Series Street Lighting Circuits, The Use of Eight-Pole Potheads for Multiplying 100-Ampere Primary-Feeder Cables, etc.

CAPACITORS

The Application and Performance of Series Capacitors, M. I. Alimansky. *Gen. Elec. Rev.*, vol. 33, no. 11, Nov. 1930, pp. 616-625, 17 figs. Function of capacitors; comparison with other regulative equipment; applications for line regulation, for division of load in loop circuits, protection of equipment, analysis of capacitor installation; article is followed by report of sub-committee on series capacitors for voltage regulation in which table is shown of line drop in per cent of receiver voltage when all reactance is neutralized by series of capacitors; also chart useful in transmission-line design.

CIRCUIT BREAKERS

Oil. New Departure in Oil Switch Fuse Design. *Elec. Times (Lond.)*, vol. 78, no. 2036, Oct. 30, 1930, pp. 751-752, 3 figs. Rotary switch action applied to oil switches secures important advantages and safety of operators.

COMMUTATORS

Electric. Phenomena Connected With the Collection of Current From Commutators and Slip-Rings, H. G. Taylor. *Instn. Elec. Engrs.—Jl. (Lond.)*, vol. 68, no. 406, Oct. 1930, pp. 1356-1363, 16 figs. Experimental investigation of copper picking, followed by critical survey of existing data, leading to explanation to account for this deposition of metal, and investigation into mechanism of passage of current from slip ring or commutator to brush; variation of contact voltage drop with speed, brush pressure and current is shown. Bibliography.

CONDENSERS

Induction Motor. The Use of Condensers for Operating Single-Phase Induction Motors. *Elec. News (Toronto)*, vol. 39, no. 12, Nov. 1, 1930, pp. 50-51, 5 figs. Use of condensers for generating artificial rotary field; starting of electric motors for domestic use; systems and connections are shown.

Static. Static Condensers as Phase Compensators (Statische Kondensatoren als Phasenkompensatoren), A. Imhof. *Schweiz. Electrotechnischer Verein (Association Suisse des Electriciens)—Bul. (Zurich)*, vol. 21, no. 20, Oct. 22, 1930, pp. 653-666, 12 figs. Construction of condensers for reactive power compensation, economic limits; numerical example in which is shown how power-factor improvement can lead to savings in power cost; economic advantages of static condensers over rotating equipment; space requirements; accessories.

CORONA

Loss Measurements. The Measurement of Corona Losses, F. M. Denton. *Gen. Elec. Rev.*, vol. 33, no. 11, Nov. 1930, p. 615, 2 figs. Current measurements on line were taken with one line grounded; combination with stroboscopic measurements; in addition to measurements such as usually are made on low voltage side of transformer supplying power to line.

EDUCATION

Engineering. Present Trends in Engineering Education, H. Tucker. *Eng. News-Rec.*, vol. 105, no. 21, Nov. 20, 1930, pp. 806-807. Colleges and universities foster multiplication of types of engineers by providing many special vocational courses; vocational aim in engineering education; branches of engineering included in curricula of 71 schools; lack of uniformity; five main divisions of engineering; modern languages in curricula; broader engineering classifications needed.

ELECTRIFICATION

Coal Mines. Modernizing a Large Western Coal Mine with Electricity, R. S. Trowsdale. *Elec. News (Toronto)*, vol. 39, no. 21, Nov. 1, 1930, pp. 47-49, 5 figs. Crow's Nest Pass Coal Co. in British Columbia, was operated entirely by steam power; in 1928 it was decided to purchase number of large air compressors, and question of economical purchase of power came up for consideration; power supply is from East Kootenay Power Co.; suitable substation provided by power company adjoining compressor station; primary current at 66,000 volts is transformed to 2300 volts for 600 and 400 hp. 3-phase 2300-volt motors.

Copper Mines. Electrification of the Utah Copper Mine, R. Corfield. *Gen. Elec. Rev.*, vol. 33, no. 11, Nov. 1930, pp. 600-607, 14 figs. Reasons why electric shovels and locomotives are used in one of largest mining undertakings in world; comparative shovel costs and comparative shovel characteristics; power input graphs for d-c. and a-c. shovels; electric locomotives; overhead line construction; locomotive data; control room; power transmission; specifications of forms of electric locomotives and shovels.

ELECTRIC DRIVE

Iron and Steel Plants. A Comparison of Alternating-Current and Direct-Current Motors for Auxiliary Drives, G. Fox. *Iron and Steel Engr.*, vol. 7, no. 10, Oct. 1930, pp. 505-511, 7 figs. In planning for expansion of steel industry of U.S.S.R., German consultants, reflecting prevailing German practice recommended use of a-c. auxiliary motors while Americans recommended 230 volt d-c. motors for services of intermittent character where mill-type motors are applicable; as this is question wherein experience and judgment are of greater importance than theoretical considerations, writer addressed questionnaire to 20 members of A.I.S.E.E. soliciting opinions and comment; analysis of questionnaire.

Paper Machinery. Modern Standards in Sectional Paper Machine Drive, R. R. Stoltz. *Paper Trade Jl.*, vol. 91, no. 15, Oct. 9, 1930, pp. 49-51, 7 figs. Automatic speed regulation by field control, moderate-speed geared motor, automatic starting and speed control equipment concentrated in single control board, generator system of starting, inching and slow speed operation, carbon pile voltage regulators individual drive of cylinder moulds and presses on wet end of board machines, carbon pile sectional speed regulator.

Strip Mills. Synchronous Motors for Main-Roll Drive, H. W. Harper. *Elec. Jl.*, vol. 27, no. 11, Nov. 1930, pp. 657-659, 4 figs. With increasing amount of attention now given to power-factor conditions, and notable improvements made in design of synchronous motors, this type of drive merits serious consideration for almost any large or reasonably large constant-speed application.

FURNACES.

Electric Furnaces, V. O. Cutts. *Elec. Rev. (Lond.)*, vol. 107, no. 2760, Oct. 17, 1930, pp. 617-619, 5 figs. Application to industrial heating, with special reference to resistance type; notes on growing application; continuous-type furnaces; precision in heat treatment; bright annealing; vitrous enameling; high-temperature furnaces; economic considerations; ideal electrical load.

Melting Cast Iron. Using Off-Peak Power for Melting Gray Iron, W. R. Jennings. *Metals and Alloys*, vol. 1, no. 17, Nov. 1930, pp. 814-815, 1 fig. Experiences of Baker-Perkins Co. of Saginaw, in operating rocking type electric furnace on cold stock melting of gray iron; charts illustrate how demand was reduced from 960 kv-a. to 640 kv-a., difference of 320 kva. which represents saving in demand charge of $5500.00 per yr.; using 590 kw-hr. per heat, cost of electrical energy per pound is 0.00295 cent.

Heat Treating. High-Speed Steel Treated in a Special Electric Furnace, E. N. Brookings. *Iron Age*, vol. 126, no. 19, Nov. 6, 1930, pp. 1295-1298, and 1360, 2 figs. Details of construction and operation of electric hardening furnace at plant of Jones and Lamson Machine Co., Springfield, Vt. for treating threading chasers for automatic dies, taps, lathe tools, and miscellaneous parts.

FUSES.

Rupturing Characteristics of High-Tension Fuses. *Elec. World*, vol. 96, no. 19, Nov. 8, 1930, pp. 870-871, 4 figs. Tests conducted for several years by Alabama Power System at short-circuit laboratory constructed for purpose at Bessemer substation; data indicate satisfactory operation at currents up to peak value of over 8500 amperes at 44 kv. and nearly 2000 amperes at 110 kv.

Re-Fusing Switches. Pole-Top Re-Fusing Made Easier, C. L. Lawrie. *Elec. West*, vol. 65, no. 5, Nov. 1, 1930, p. 233, 2 figs. To provide quicker and safer method of re-fusing poletop line switches on its 12-kv. distribution lines without resorting to use of hot-line tools and without killing line, new switching arrangement has been developed by San Diego Consolidated Gas & Electric Co.; system is detailed.

HEATERS

Water. Economic Advantages of Off-Peak Water Heating, L. L. Eden. *Elec. World*, vol. 96, no. 19, Nov. 8, 1930, pp. 863-869, 6 figs. Typical winter and summer loads showing availability of off-peak power; favorable characteristics of off-peak load; comparative cost of on and off-peak water heating; typical load curves of city and suburban a-c. substation for December and June; performance of water heaters at various hours and rates of water usage; comparative cost of fuels for water heating.

HEATING

Domestic. Off-Peak System of Electric Heating for Buildings, E. Harrington. *Heat., Piping and Air Conditioning*, vol. 2, no. 11, Nov. 1930, pp. 963-967, 6 figs. Operating cost of electric heating depends upon number of variables, among which are power rate and characteristics of building to be heated; table illustrates energy used for electrically heating 18 houses, Fort Wayne, Ind.; list of advantages of electric heating; domestic water heating.

HYDRAULIC MACHINERY

Cavitation. Experimental and Theoretical Investigations of Cavitation in Water [Experimentelle und theoretische Untersuchungen ueber Hohlraumbildung (Kavitation) in Wasser], J. Ackeret. *V. D. I. Zeit. (Berlin)*, vol. 74, no. 9, Mar. 1, 1930, p. 264. Investigation of simple types of flow, such as those round blades, through channels, and past spheres, has been done at Goettingen; it was found that many apparently widely different types of cavitation are of quite common characteristics; investigations show that at core of bubbles shock pressure is sufficient to cause observed breakdown of material.

HYDROELECTRIC POWER PLANTS

Report of Hydraulic Power Committee (Eng. Sec.) presented at 23rd annual mtg. of Pa. Elec. Assn. (Eastern Geographic Div. N.E.L.A.), Bedford Springs, Pa., numerous figs. and tables. Minutes of meetings; manufacturers' statements as to volume and equipment of hydroelectric installations; during past 12 months orders were placed for Smith turbines developing more than 591,000 h.p., including 81,900 h.p. in propeller type units; Flow Measurement and Forecasting at Holtwood, H. W. Lowy. Output Standards for Hydraulic Units, C. W. Watchorn; Keeping Daily Record of Capacity of Hydro Units, R. D. Shaub; Distribution of Runoff and Rainfall in Susquehanna Valley, C. F. Merriam and E. S. Loane; Seiches in Conowingo Pond, R. Taylor and R. E. Turner; Progress in Remodeling York Haven Hydro-Electric Station, A. W. Reid; list of dam failures.

Ice Control. Ice-Trouble Remedies in Hydro-Electric Plants, C. R. Reid. *Power*, vol. 72, no. 19, Nov. 4, 1930, pp. 728-730, 7 figs. How to keep sluice gates, flashboards, rack bars, headgates, penstocks, surge tanks and waterwheels in operating condition in cold climates; use of steam, hot water and electric heating, compressed air, and electric lights are included in suggested methods.

INSULATORS

Testing. Field Testing of Insulators on Overhead Lines, D. Harvey. *Distribution of Electricity (Lond.)*, vol. 17, no. 2, Oct. 1929, pp. 223-225, 3 figs. Mechanical faults are particularly noticeable among "cap and pin" type of suspension insulator; "Hewlett" type of insulator, in which hardware is interlocked so that porcelain is in compression, appears to give slightly better service than "cap and pin" types; string type insulators for excellent results; authors experience with string type insulators in 88 kv. line. Extracts from lecture recently delivered to Inst. of Engrs. in Tasmania. (To be concluded.)

INTERCONNECTION

Industrial Power Plants. Engineering Aspects of Interchange of Power With the Industrial Plants, B. F. Wood. *Am. Soc. Mech. Engrs.—Advance Paper*, no. 57, for mtg. Dec. 1-5, 1930, 5 pp. Establishment of means and facilities for utilizing massed resources to serve power requirements of individual industries; economical operations can be effected and overhead costs greatly reduced in great many cases where public utility or other steam-generating or hydro power plants find it possible to hook up with large industrial operations; advent of high steam pressures has largely increased these possibilities.

LAMPS

Gas-Filled. Electric Lighting by Gaseous Discharge Tubes, C. C. Paterson. *Engineering (Lond.)*, vol. 130, no. 3381, Oct. 31, 1930, p. 560. Abstract of portion of presidential address before Institution of Electrical Engineers, dealing with gaseous discharge tubes; although so much work has been done on hot cathode tube, many interesting developments of original cold cathode tubes are taking place; under certain conditions, which are only just beginning to be understood discharge instead of filling whole tube, as is normally the case is concentrated into narrow cord only one-fifth of diameter of tube.

Glow. Duration of Emission Phenomena in Glow Lamps (Ueber die Zeit-dauer der Emissionserscheinungen bei Glimmlampen), H. Peters. *Fernsehen (Berlin)*, vol. 1, no. 7, July 1930, pp. 306-310, 2 figs. Quality of picture in television greatly depends on design of glow lamp; investigation of inertia phenomena in this device allows for making conclusions which are of importance in instruction.

Street—Reactors. Investigation of Choke Coils for Parallel Connection to Incandescent Lamps in series for Keeping up of Operation in Case of Burn-out of Lamps (Untersuchung ueber Drosselspulen zur Parellelschaltung mit Gluehlampen, die in Serie geschaltet sind, zur Aufrechthaltung des Betriebes bei Durchbrennen einer oder mehrerer Lampen), I. Ehrenstein. *Elektrotechnik und Maschinenbau (Vienna)*, vol. 48, no. 40, Oct. 5, 1930, pp. 913-915, 5 figs. Performance, characteristics and design data for reactive coils hooked in parallel to lamps in series street lighting for emergency in case of lamp burn-out.

LIGHTING

Industrial. Light and Its Relation to Output, H.C. Wheat. *Machy. (Lond.)*, vol. 37, no. 942, Oct. 30, 1930, p. 135. Relative advantages of various lighting arrangements; good artificial lighting promotes safety, increases production, reduces errors and improves morale of employees; proper use of various types of reflectors; data on light intensities in machine shop. Abstract of paper read before Rugby Eng. Soc.

LIGHTNING ARRESTERS

Lightning Arrester Practise in Southern California, E. R. Stauffacher. *Elec. West*, vol. 65, no. 5, Nov. 1930, pp. 230-231, 5 figs. Instead of following older practise of installing one set of lightning arresters upon each of lines entering and leaving substation, Southern California Edison Co., Ltd., is now following simplified practise of installing lightning arresters only on transformer banks; details of system are given.

MEASUREMENT

Stresses. Use of Telemeters for Measurement of Stresses in Structures (Die Verwendung von Telemetern zu Spannungsmessungen au Bauwerken), F. Treiber. *Bauingenieur (Berlin)*, vol. 11, no. 37, Sept. 12, 1930, pp. 633-636, 14 figs. Description of instrument developed by U. S. Bureau of Standards and report on German tests of this instrument by Probst, at Karlsruhe Institute of Technology.

Electric. Metering Combined Power and Lighting Loads, H. W. King. *Elec. World*, vol. 96, no. 17, Oct. 25, 1930, pp. 774-776, 11 figs. Condition, varying from large power load with small lighting load to large lighting load with small power load, with or without demand with diversity factor included, defeat adoption of one uniform metering scheme for all cases; it is illustrated how some of these conditions may be met and to point out advantages or disadvantages of various combinations which may be used.

Reactive Power. Reactive Kv-a. Metering, E. C. Goodale. *Elec. West*, vol. 65, no. 5, Nov. 1, 1930, p. 232, 2 figs. Cross-phase connections provide required phase relations for reactive kv-a. metering on two-phase circuit. (Continuation of serial.)

MOTORS

Torque. Torque Characteristics of Electric Motors, W. T. Burdick. *Power Transmission*, vol. 37, no. 3, Sept. 1930, pp. 15-17. Common types of direct and alternating-current motors; starting torque, full-load running torque, and maximum torque; table of characteristics and typical applications of motors.

Variable Speed. Multispeed Motors for a Multitude of Uses, R. H. Rogers. *Power Plant Eng.*, vol. 34, no. 22, Nov. 15, 1930, pp. 1289-1292, 5 figs. Two, three and four-speed, speeds available, speed control, and examples of applications.

NETWORKS

Design. Municipalities Gain from Network Distribution, A. Hussey. *Elec. World*, vol. 96, no. 17, Oct. 25, 1930, pp. 770-772, 8 figs. Under present system it is possible to transmit as much power as under old d-c. system in duct space reduced in ratio of 51 to 1; this has been made possible by development of cable capable of operating at 27,000 volts with high degree of dependability, and of automatic protective devices to clear cable or other device in event of failures; as direct result of decreased duct space and increased capacities, number of line manholes and dimensions of these manholes have been reduced.

OSCILLOGRAPHS

Cathode Ray. Cathode-Ray Oscillograph as Precision Measuring Equipment (Der Kathodenoszillograph als Praezisionsmessgeraet), H. Viehmann. *Archiv fuer Elektrotechnik (Berlin)*, vol. 24, no. 3. Sept. 27, 1930, pp. 349-352, 6 figs. Determination of overvoltage and spark-delay time in puncture testing of air required exact values of first mentioned; it is investigated whether cathode-ray oscillograph is suitable equipment for this purpose.

PHOTOELECTRIC CELLS

Photo-electric Cells, T. T. Baker. *Elec. Rev. (Lond.)*, vol. 107, no. 2762, Oct. 31, 1930, pp. 722-723, 5 figs. Some industrial applications; effect of voltage on output for vacuum cell and gasfilled cell; effect of gas-pressure on output; photoelectric cell circuits. (To be concluded).

POWER SUPPLY

Rural. The National Rural Electric Project and the Agricultural Problem, G. W. Kable. *Baltimore Engr.*, vol. 5, no. 7, Oct. 1930, pp. 4-8 and 24, 7 figs. Aim of project is to improve living conditions and income on American farms, to lessen fatigue and to increase leisure time of farm homemakers, and to ascertain truth concerning economic use of electricity on farm; work consists of practical demonstration of possible uses of electricity on farms, together with investigation and research in application of electricity to agriculture.

Present Status of Research in Rural Electrification, G. W. Kable. *Nat. Elec. Light Assn.—Bul.*, vol. 17, no. 11, Nov. 1930, pp. 693-695, 1 fig. Electrification of agriculture is not problem in motorizing of industry; farming bristles with problems in chemistry, physics, biology, bacteriology, economics and sociology, all of which may be influenced to degree through application of electricity.

PUBLIC UTILITIES

Legislation. Some Influences on Public Utility Legislation, A. F. Tegen. *Nat. Elec. Light Assn.—Bul.*, vol. 17, no. 11, Nov. 1930, pp. 682-685, 8 figs. Net earnings of electric utilities are not excessive when considered in relation to other businesses; if this industry is to maintain its position with respect to its ability to obtain money for improvements, conditions under which it is operating should not be disturbed; analysis of municipal and private utility operation in Wisconsin reveal that whereas municipal utilities started with more revenue per kw-hr. they ended with less.

RADIO

Screen Grid Amplifiers. Application of Screen Grid Tubes to Audio Frequency Amplifiers, J. J. Glauber. *Radio Eng.*, vol. 10, no. 2, Feb. 1930, pp. 29-32 and (discussion) 32-33, 10 figs. Construction of proper circuits suitable to characteristics of typical screen-grid tube. Paper presented before Radio Club of America.

Communication Aerial. Radio for Aircraft. *West. Flying*, vol. 8, no. 5, Nov. 1930, pp. 40-41, 1 fig. Review of recent progress with particular regard to new Department of Commerce regulations governing aircraft radio equipment; effective Dec. 31; advantages of two-way radio phone communication.

Ultra Short Wave. Practical Experiments in Ultra-Short Wave Communication, C. C. Whitehead. *Experimental Wireless (Lond.)*, vol. 7, no. 86, Nov. 1930, pp. 612-620, 11 figs. Range tests and propagation; screening of envelopes of valves, asymmetry of circuit; estimation of transmitter efficiency, effect of time of transit of electrons constituting space-current, constructional details of transmitter and constructional details of receiver, are given in appendix. Bibliography. (Concluded.)

Developments in Ultra-High Frequency Generation, C. W. Loeber. *Electronics*, vol. 1, no. 8, Nov. 1930, p. 376, 2 figs. Barkhausen-Kurz effect was produced with triode with strong positive voltage on grid; voltages determined frequency; wavelength was measured by moving crystal detector along Lecher wires; Gill and Morrell's oscillating circuit in which frequency could be varied by telescoping tubes.

RAILROADS

Electrification—United States. N.E.L.A. Electrification Report. *Ry. Age*, vol. 89, no. 19, Nov. 8, 1930, pp. 974-979, 6 figs. Study of installations on western railroads has developed much useful information concerning operation and maintenance.

Operation. Scheduled Speed Increased by Electrification. *Elec. Ry. Jl.*, vol. 74, no. 12, Nov. 1930, pp. 683-684, 2 figs. Rapid acceleration and braking rates of new electric trains have enabled Lackawanna Railroad to reduce running time by approximately 25 per cent between Hoboken and stations in suburban zone; free running speed also higher than that of steam trains formerly operated.

Substations. The Design and Operation of the Windsor, Essex and Lake Shore Railway Automatic Substations, H. V. Armstrong. *Elec. News (Toronto)*, vol. 39, no. 21, Nov. 1, 1930, pp. 31-34, 5 figs. Diagram of automatic switching equipment for synchronous converters in railway service; sequence of operation; 26.4 kv. switching equipment of notes on operation of 36 mi. line connecting Windsor to Leamington and running through Maidstone, Essex, Cottam, Ruthven and Kingsville, serving county of Essex.

Terminal Electrification. Overhead System of Cleveland Terminal Electrification, L. W. Birch. *Elec. Traction*, vol. 26, no. 10, Oct. 1930, pp. 535-537, 3 figs. Review of electrified terminal stations; 3000 volts d-c. decided upon; insulation details of overhead.

REACTORS

Design. Current-Limiting Reactors, A. H. v. Altmann. *AEG Progress (Berlin)*, vol. 6. no. 11, Nov. 1930, pp. 341-345, 7 figs. Calculation and effects of short-circuit currents; impedance calculation of short-circuit path; thermal and dynamic effects of short-circuit current; construction and installation of current-limiting reactors.

RECTIFIERS

High-Tension. Generation of High-Tension Direct Current from Three-Phase A.C. Current (Die Erzeugung von hochgespanntem Gleichstrom aus Drehstrom), W. Deutsch and W. Hoss. *Elektrotechnische Zeit. (Berlin)*, vol. 51, no. 43, Oct. 23, 1930, pp. 1480-1483, 18 figs. Construction, performance and application of novel mechanical high-tension rectifier by which it is possible to obtain d.c. of voltage approximately equal to maximum value of transformer voltage.

RELAYS

Protective. D.-C. Undervoltage Relay Controls A-C. Circuits, W. M. Brainard. *Power*, vol. 72, no. 19, Nov. 4, 1930, pp. 725-727, 5 figs. Inductor-type d-c. time-delay undervoltage release has been developed that is applied through copper-oxide rectifier to protect a-c. equipment against voltage failures; applications diagrams of inductor-type time-delay device.

TELEVISION

History. Historical Development of Television (Die Geschichtliche Entwicklung des Fernsehens), W. Friedel. *Fernsehen (Berlin)*, vol. 1, no. 1, Jan. 1930, pp. 12-17, 5 figs. General notes on development from 1875 to present.

Life Size. Life Size Television on the Screen (Fernsehen in Lebensgroesse auf der Leinwand), A. Neuburger. *Fernsehen (Berlin)*, vol. 1, no. 10, Oct. 1930, pp. 460-463, 3 figs. Successful transmission by Dr. Alexanderson of picture and voice of living persons and actors over distance of some miles on 10 by 11 ft. screen in 2500 persons theater in Schenectady; equipment is illustrated.

TRANSMISSION LINES

Construction. The Stringing and Sagging of Overhead Line Conductors, H. W. Settle. *Elec. Engr. of Australia and New Zealand (Melbourne)*, pp. 209-213, 5 figs. Practical methods for overhead transmission lines and of tensioning them to correct sag, particularly in rough country; several methods of sagging are given, some involving use of theodolite; wave method, in which sag is determined from speed of travel along wire of mechanically produced wave.

Gounding. Further consideration is Needed on Grounds and Ground Testing, W. B. Buchanan. *Elec. Canada (Toronto)*, vol. 2, no. 9, Sept. 1930, pp. 22-24 and 34, 1 fig. Subject is outlined so that various views presented may appear in proper relation to entire subject and less contradictory to one another than they occasionally have done.

Protection. Summation Transformer Gives Overcurrent Protection, R. E. Cordray. *Elec. World*, vol. 96, no. 19, Nov. 8, 1930, p. 872, 2 figs. To raise ampere setting of overcurrent relays automatically on two parallel lines when one of lines is temporarily out of service for any reason, New England Power Co. adopted novel arrangement by bridging auto-transformer by overcurrent relay and connecting midtap to common connection of cross-connected current transformers.

Theory. Transmission of High-Frequency Oscillating Electric Power (Die Fortleitung hochfrequenter elektrischer Schwingungsenergie), H. O. Roosenstein. *Zeit. fuer Hochfrequenztechnik (Frankfort)*, vol. 36, no. 4, Oct. 1930, pp. 121-123, 17 figs. Data of lines applied in practise; wave resistances, damping, numerical example; theory of damping measurements; observation of safety in measurements, etc.; asymmetry of two wire lines; experiments, removal of line asymmetry.

TRANSMISSION LINES, HIGH TENSION

Design. Transmission Tower Design for Maximum Lightning Protection, Fortescue. *Elec. Jl.*, vol. 27, no. 11, Nov. 1930, pp. 640-644, 8 figs. Calculated results for tower of horizontal construction with transmission lines 76 ft. above surface of earth and ground wires in vertical plane 25 ft. above line wires is given; from curves can be determined necessary length of insulator string to withstand surge potential due to lightning stroke on ground wire or value to which tower-footing surge impedance must be reduced in order to prevent flashover of given length of string.

Protection. Protection from Surges, E. T. Norris. *Elecn. (Lond.)*, vol. 105, no. 2734, Oct. 24, 1930, pp. 496-497, 3 figs. Safeguarding of apparatus against lightning and other surges; discharge arresters giving place to surge absorbers.

Theory and Application of Relay Systems, P. H. Robinson and I. T. Monseth. *Elec. Jl.*, vol. 27, no. 11, Nov. 1930, pp. 660-668, 37 figs. Notes on apparatus protective relays; equipment is illustrated; characteristic curves are given. (Continuation of serial.)

TRANSFORMERS

Current. Factors in Connecting Secondaries of Current Transformers, J. Auchincloss. *South Power Jl.*, vol. 48, no. 11, Nov. 1930, pp. 51-53, 4 figs. When current transformer secondaries should be connected in series and when in parallel, and effect of each connection on division secondary burden; analysis of problem.

Oil-Immersed Current Transformers, I. H. Sclater. *Gen. Elec. Rev.*, vol. 33, no. 11, Nov. 1930, pp. 658-659, 6 figs. New types of oil immersed current transformers and described under headings; accuracy; connections; bushings tanks; by-pass protectors.

TURBO-GENERATOR

Rotors. Stresses in Retaining and Centering Rings for Turbine-Generator Rotors, R. Patterson and D. H. Harms. *Am. Soc. Mech. Engrs.—Advance Paper*, no. 42, for mtg. Dec. 1-5, 1930. 9 pp., 8 figs. Distribution of stresses throughout system of parts enclosing rotor coil ends of turbine generator; system consists of disk of uniform cross-section cylinder, and part of shaft; summary of significant results.

VACUUM TUBES

Filaments. The Role of Barium in Vacuum Tubes, J. A. Becker. *Electronics*, vol. 1, no. 8, Nov. 1930, pp. 390-391, 2 figs. It is shown how ionic barium grid accounts for many of observed emission characteristics of coated filaments; for all thousands of tubes in use in Bell System total amount of effective barium is not more than twentieth of gram; each barium-coated filament requires only about 2.2 watts for heating as compared to about 35 for clean tungsten filament; multiplying this saving by 250,000 tubes used in Bell System gives indication of tremendous importance of barium to vacuum tubes.

Oscillators. The Effect of Combined A.C. and D.C. Plate Supply on a Short Wave Triode Oscillator, G. S. Field. *Can. Jl. Research (Ottawa)*, vol. 3, no. 4, Oct. 1930, pp. 287-290, 3 figs. By combining a.c. and d.c. on plate of triode oscillator, more stable and much stronger oscillations were obtained than with pure d.c.; increases in radio frequency current up to 2.5 times were noted; experiments with 200-cycle and 60-cycle a-c. showed that higher frequency gave stronger oscillations.

Rectifier. Vacuum-Tube Rectifiers Control Motor Speed, W. R. King.

Power, vol. 72, no. 20, Nov. 11, 1930, pp. 761-763, 6 figs. Operation of thyratron, mercury-arc rectifier with grid control, and its application to control speed of d-c. motors supplied by a-c. circuits; diagram of single-phase full-wave grid-controlled thyratron rectifier.

WATER POWER

United States. Federal Relations to Water-Power Development, F. E. Bonner. *Am. Soc. Mech. Engr.—Advance Paper*, no. 8, for mtg. Dec. 1-5, 1930, 3 pp. Survey of part played by Federal Government; Federal jurisdiction over navigable streams; purpose of Federal Water-Power Act; activities of Federal Power Commission; aggregate capacity of water power plants under license.

WELDING

Arc. Application of Electric Arc Welding to Building and Machine Construction, J. M. Hipple and G. D. Fish. *Eng. and Finance*, vol. 23, nos. 4 and 5, Oct. 1930, pp. 111-112, and Nov., pp. 145 and 158, 8 figs. Abstract of paper presented before Inst. Congress of Steel Construction, Belgium, and previously indexed from Welding Engr., Sept. 1930. (To be continued.)

Arc—Atomic Hydrogen. Welding with Atomic Hydrogen Process, S. Martin, Jr. *Welding*, vol. 1, no. 13, Nov. 1930, pp. 907-909 and 912, 7 figs. Fundamental principles and electric equipment; connection diagram for atomic-hydrogen arc-welding equipment; graph illustrates tungsten electrode consumption, average welding speed, and average welding curve for steel plates.

Buildings, Steel. Welding a 14-Story Building, J. L. Faden. *Elec. World*, vol. 96, no. 18, Nov. 1, 1930, pp. 824-829, 10 figs. Details of electric welding of two Boston Edison Co.'s buildings; nearly mile of electric welds, consuming 6120-kw-hr.; 1054 tons of steel welded; average inches of weld per man per hr. 47.4; operators selected to qualify for this important undertaking; building welds specified in detail; advantages of welding; summary of welding inspection reports; welding data; details of welded steel frames.

Pipe, Steel. Electrically welded Steel Water Pipe, W. H. Powell. *Can. Engr. (Toronto)*, vol. 59, no. 19, Nov. 1930, pp. 599-604, 5 figs. Description of methods used in making and testing of 50,000 ft. of pipe in British Columbia for Greater Vancouver water district's system; butt-weld and lap-weld tests; fitting pipe sections; cleaning and dipping; manufacturing pipe bends; hand-weld and machine-weld tests; hydrostatic test; pipe diameters varied from 26 to 36 in.

X-RAY APPARATUS

The Development of Modern X-Ray Generating Apparatus, W. D. Coolidge. *Gen. Elec. Rev.*, vol. 33, no. 11, Nov. 1930, pp. 608-614, 18 figs. Early type of tube by Roentgen; Jackson's first tube employing focused cathode rays: development of ductile tungsten; tungsten target; manufacture of photomicrograph of crystalline structure of tungsten before and after swaging; hot-cathode tube; types of tubes; heat removal from focal spot; 500,000-volt X-ray tube built in two sections; tubes for very high-voltage X-ray therapy. Abstract of lecture before Am. Roentgen Roy. Soc., Sept. 24, 1930. (To be continued.)

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NEW BOOKS AVAILABLE NOVEMBER 1-30, 1930

UNLESS otherwise specified, these books have been presented by the publishers; the Institute assumes no responsibility, all statements being taken from the preface or the text of the book.

A. S. T. M. TENTATIVE STANDARDS, 1930. By American Society for Testing Materials. Philadelphia, The Society, 1930. 864 pp., illus., diagrs., tables, 9 x 6 in., paper. $7.00; cloth, $8.00.——This new edition contains 155 specifications, methods of testing, etc., that have not yet been adopted finally by the Society as standards, but are under consideration, and are offered for criticism. They cover the whole field of engineering materials, there being specifications for various metals, cement, clay products, preservative coatings, road materials, insulating materials, coal and coke, and various other substances.

COMMERCIAL A-C. MEASUREMENTS. By G. W. Stubbings. N. Y., D. Van Nostrand Co., 1930. 325 pp., diagrs., 9 x 6 in., cloth, $6.00.——This book aims to occupy a position between the descriptive treatise and the handbook of test methods. The author omits details of the construction of instruments and confines descriptive matter to that necessary to elucidate the principles of methods, using the space gained for a fairly exhaustive presentation of the theory and practise of the measurement of current, voltage, power, energy, and power factor. Three-phase measurements are treated rather fully. A chapter is devoted to test-room equipment. The work is intended for testing engineers.

GOETHALS, GENIUS OF THE PANAMA CANAL; a Biography. By Joseph Bucklin Bishop and Farnham Bishop. N. Y. and Lond., Harper & Bros., 1930. 493 pp., illus., ports., 10 x 6 in., cloth. $5.00.——A vivid and interesting account of General Goethal's career covers his various activities at West Point, as an army engineer, at the head of the Panama Canal work, and in later life. The work is based on intimate acquaintance and access to many private sources of information, the senior author having been secretary of the Isthmian Canal Commission.

INTRODUCTION TO SURFACE CHEMISTRY. By Eric Keightley Rideal. 2nd edition. Cambridge, Eng., University Press; N. Y., Macmillan Co., 1930. 459 pp., diagrs., tables, 9 x 6 in., cloth. $6.00.——The rapid growth in the study and industrial use of colloidal systems makes desirable an adequate understanding of the properties of surfaces and interfaces. This book aims to review our present knowledge of interfacial systems, in a volume of reasonable size. Students of colloids will find it a valuable introduction to the subject.

KRAFTWERKS-BAUTEN. [2nd edition]. Berlin, Siemens-Schuckert, [Published by V. D. I. Verlag, 1930]. 138 pp., plates, 12 x 8 in., bound. 6. r. m.——A volume of photographs and plans of a number of electric power plants recently built by the Siemens-Schuckert works. The layout and construction of the buildings are considered, not the equipment. Brief data about capacity and equipment are given, with references to more comprehensive published description.

REGELN FÜR ABNAHMEVERSUCHE AN WASSERKRAFTMASCHINEN. 2d edition. Berlin, V. D. I. Verlag, 1930. 8 pp., illus., 12 x 8 in., paper. 1,50 r. m.——These rules for acceptance tests of hydraulic turbines have been formulated by a joint committee of the German associations of engineers and hydraulic interests, with the cooperation of Austrian and Swiss societies. The present revision corresponds to the standards of the International Electrotechnical Commission.

THE SELENIUM CELL; its Properties and Applications. By George P. Barnard. N. Y., Richard R. Smith, Inc., 1930. 331 pp., illus., diagrams, 10 x 6 in., cloth, $9.00.——This valuable monograph aims to present a precise, accurate survey of our knowledge of the properties of selenium and of the applications of selenium cells to photophony, television, talking films and other practical uses. The scattered literature has been very thoroughly summarized and an exhaustive bibliography is included in the book, which will be found most useful by all workers in this field.

STATISTIK FÜR DAS JAHR 1929. By Vereinigung der Elektrizitätswerke. Dortmund, W. Crüwell, 1930. 687 pp., map, 12 x 9 in., boards. 50.-r. m.——An elaborate statistical analysis of the electricity supply of Germany, with data also for a number of power plants in neighboring countries. The data for each plant are very complete and include the information usually wanted as to sources of power, size, efficiency, rates, methods of distribution, equipment, etc.

Tables Annuelles de Constantes et Données Numériques. Table des Matieres, v. 1-5; 1910-1922. Paris, Gauthier-Villars et cie., N. Y. McGraw-Hill Book Co., 1930. 382 pp., 11 x 9 in., cloth. $20.00——The appearance of this index will be welcomed by all users of the Annual Tables of Constants. It contains analytic, alphabetic, and formula indexes to the material in the first five volumes of the tables, thus making it a simple matter to find what is wanted, and making the set much more useful than it has been.

Local Meetings

Group Activities— What Do They Mean?

When a national organization such as the American Institute of Electrical Engineers is established in a field just coming into being as it was in 1884, its progress over a period of a few years is often phenomenal. The men who had the initiative, spirit and willingness to make the start remain with their shoulders to the wheel, and their enthusiasm is contagious; it spreads without effort, and new members flow into the organization without the necessity of a membership campaign. And, the entire field being of small compass, all are familiar with its various phases, a common interest providing the incentive which keeps the wheels turning.

Years elapse, and the organization grows geographically to become national, and even world-wide. The electrical field is now one of the most complex of its kind, its branches extending from most profound pure science through all the scope of applied sciences. No longer is an all-embracing group possible nor can any one individual master the entire field. Geographical segregation and technical specialization have of necessity crept in and are increasing with time. Groups of men within the big family circle now have interests separate and distinct from those of another division in the field, making for a tendency to break away—to form independent organizations, each devoted to its own local interests and its own specialty.

To take care of this from the geographical standpoint and counteract so far as possible the disadvantage of the hundreds—and even thousands—of miles intervening between centers of activity, the Institute in 1902 approved a plan for the organization of "Sections" in these electrical centers; also for the grouping of engineering students into "Branches" in the universities and technical schools. The step resulted in an immediate rise of the membership curve. In 1919 further effort to give each member opportunity to play his individual part in the progress of the Institute, and to profit by its activities, was evidenced by dividing the country into "Districts" and with a vice-president for each District. Innovations during the following years created various coordinating committees within the Districts and made provision for the payment of certain traveling expenses of delegates. Thus the geographical segregations of the organization knit themselves together. As for the specialization tendency—it, too, has continued to develop, and just so far as conditions would warrant, effort has been made to provide each technical group with papers, sessions, and even meetings, devoted to its specific interests. There was, however, and is, a very definite limit to which this could be carried in time, number of meetings, and finances. Consequently, especially with the larger Sections, lack of interest became evident, and without almost unwarranted effort, good attendance at meetings was difficult to obtain unless meetings included subjects of highly controversial interest or were addressed by effective speakers of national prominence.

Into the picture at this point came the suggestion of "Groups" within the Sections. Chicago and New York immediately put such division into action, New York organizing four groups—Power, Transportation, Communication, and Illumination. So far as possible, execution of plans was placed in the hands of the younger men, who were also expected to provide most of the papers for their group meetings. Free and open discussion at all meetings was encouraged and as expected, the younger men who had never previously been heard at the larger meetings proved eager to prepare papers and take active part in the discussions.

In presenting Group subjects, the effort is always to present a picture comprehensible to those outside a particular field of activity, encouraging the attendance of other groups and broadening the interest. Attendance at Group meetings in New York has frequently equalled, or even exceeded, that formerly registered at general, monthly meetings. But as they appear to be entirely feasible the monthly meetings have continued and there is a strong desire to make such meetings of the widest general interest.

But what has resulted from two years of Group activity? Speaking from the New York point of view—and probably the same applies to Chicago—there has been awakened interest in Section activities. In a city where there are almost endless counter attractions, meeting attendance has increased and is continuing to increase. Men who appeared to have actually passed outside Institute portals have not only come back, but have done so actively, since it is now possible to find here material which they were compelled to acquire elsewhere. The younger man who felt that he had no place in the internal workings of the Institute and who often queried "What do I get out of it?" now feels, and rightly, that he has a new and very real part to play. The New York Section activities have resulted in a greatly increased rate of membership, and have incited men already members to seek advancement to the higher grades, all of which demonstrates a healthy awakening of interest.

The Group movement has apparently solved the tendency to divide and is perhaps the first step toward consolidation.

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N. Y. Section Groups to Hold Joint Meeting

Railroad power supply has aroused such wide general interest that the New York Section has arranged a joint meeting of its Transportation and Power Groups to be held on the evening of January 9, 1931. Two papers will be presented:

Power Supply for the D. L. & W. Electrification, by R. D. Booth of Jackson & Moreland, and

Some Business Aspects of Railroad Power Supply, by A. E. Banham of the Public Servic Electric & Gas Company.

Ample time will be allowed for discussion, and anyone interested is cordially invited to participate, even though he may not be affiliated with the New York Section.

The meeting will be held at 7:30 p. m. in Room 1, Engineering Societies Building, 33 West 39th Street, New York, N. Y.

Student Activities an Integral Part of Recent Louisville District Meeting

AS parts of the Southern District Meeting in Louisville, Ky., November 19-21, 1930, a student technical session, a conference on student activities, and a luncheon for counselors, chairmen, and other faculty members and students were held.

TECHNICAL SESSION

Professor D. C. Jackson, Jr., chairman, Committee on Student Activities, District No. 4, presided at the student technical session on Thursday morning, which was opened by two brief addresses as follows:

Welcome for the A. I. E. E.

Professor W. S. Rodman, Vice-President, A. I. E. E.

Student Technical Sessions

H. H. Henline, Assistant National Secretary, A. I. E. E.

Mr. Jackson announced that first, second, and third prizes of $25, $15, and $10, respectively, would be awarded by the three judges, Vice-President Rodman, and Messrs. F. M. Craft of Atlanta, and F. H. Miller of Louisville, at the conclusion of the following program presented by students:

The Romance of Television

L. C. Vipond, North Carolina State College of A. & E.

George Westinghouse—A Brief Review of His Life and Career

J. M. Leigh, Mississippi A. & M. College

Theory and Operation of "Deion Grid" Oil Circuit Breakers

Herbert L. Stokes, University of South Carolina

Cooperative Education

John G. Lips, University of Louisville

Student Branch Activities

Russell Ranson, Duke University

Duct-Line and Manhole Construction for Underground Distribution Systems

P. C. Stoll, Georgia School of Technology

An Engineer's Gift to the Invalid

T. C. Brown, University of Kentucky

Lightning Study on Martin Dam-Leeds 110-kv. Transmission Lines

J. C. Evans and H. B. Hendrix, University of Alabama (Presented by Mr. Evans)

LUNCHEON

The University of Louisville gave a luncheon on Thursday for all counselors, Branch chairmen, and other faculty members and students attending the District Meeting. Professor S. T. Fife, Head of the Electrical and Mechanical Engineering Dept., presided, and Dean B. M. Brigman gave the address of welcome.

In a most interesting and inspiring address, W. S. Lee, president of the A. I. E. E., discussed the great importance of the development of young engineers through the most beneficial kinds of education and practical experience. He then explained in detail some aspects of large engineering construction projects with which he has been connected.

Vice-president Rodman announced the awards for the presentation of student papers at the morning session, and presented prizes as follows:

First: $25, P. C. Stoll, Georgia School of Technology

Second: $15, J. G. Lips, University of Louisville

Third: $10, H. L. Stokes, University of South Carolina

CONFERENCE ON STUDENT ACTIVITIES

Professor D. C. Jackson, Jr., chairman of the District Committee on Student Activities, presided at the Conference on Student Activities held Thursday afternoon. As District counselor delegate to the Summer Convention at Toronto, he reported upon the recommendations adopted at the Conference of Officers, Delegates, and Members. He called attention to the parts of the 1930 report on Section and Branch Activities which are of particular interest to Branch officers.

The University of Florida was chosen as the location of the District Conference on Student Activities in 1931, and the consensus of opinion was that it should be held in the Fall Semester.

Professor Joseph Weil, counselor of the University of Florida Branch, was elected chairman of the District Committee on Student Activities, to take office immediately, and also counselor delegate to the Summer Convention in Asheville in June 1931.

Some of the other topics discussed are given below:

Most effective types of programs.

Improvement of attendance at Branch meetings.

Advisability of electric shows by students.

Training next year's officers of Student Branches.

Requirement of personal presentation of papers at Student Technical Sessions.

Aid from the A. I. E. E. in financing research work by students.

Financing the office expenses of the chairman of Student Activities Committee.

A vote of thanks was extended to Professor Jackson for his admirable work as chairman of the District Committee on Student Activities.

Future Section Meetings

Cleveland

January 22, 1931—FUTURE POWER DEVELOPMENT AND DISTRIBUTION IN THE CLEVELAND METROPOLITAN AREA, by H. L. Wallau, Chief Electrical Engineer, Cleveland Electric Illuminating Co.

February 19, 1931—RECENT PROGRESS IN COMMUNICATION TECHNOLOGY. Speaker from the Bell Telephone Laboratories, Inc., to be announced later.

Detroit-Ann Arbor

January 20, 1931—UNDERGROUND CABLES, by G. B. McCabe, Detroit Edison Co., and L. F. Hickernell, Allied Engineers, Inc. Meeting at Detroit Edison Auditorium.

February 17, 1931—DETROIT TOLL BOARD, by E. C. Balch, Michigan Bell Telephone Co. Meeting at Michigan Bell Telephone Auditorium.

Niagara Frontier

January 16, 1931—Dean Kimball, Cornell University, will speak on INDUSTRIAL ECONOMICS or similar subject.

February 16, 1931—AIR CIRCUIT BREAKERS, by Mr. Gunion, I. T. E. Company.

Seattle

January 20, 1931—Meeting on Communication Engineering by an engineer from the headquarters staff of the Bell Telephone Co.

February 17, 1931—OPERATING PROBLEMS OF TRUNK LINE ELECTRIFICATION, by J. Hawe, Electrical Engineer, Great Northern Railway.

Spokane

January 23, 1931—PREDETERMINATION OF TRANSIENT STABILITY, by H. V. Carpenter, Dean, College of Mechanic Arts and Engineering, State College of Washington.

Past Section Meetings

Akron

Inspection trip to the electrification and signal system of the Cleveland Union Terminal. Address by H. W. Pinkerton on the electrical and mechanical features of the project, illustrated with films and slides. November 15. Attendance 50.

Atlanta

Inspection trip through the Plant Atkinson Steam Station of the Georgia Power Co. After a buffet supper, provided by that Company, short talks were given as follows:

Georgia Power Company in the Industrial Structure of the State, by W. E. Mitchell, Vice-President, Georgia Power Co.;

Design of Plant Atkinson, by W. P. Hammond, Allied Engineers, Inc.;

Plant Atkinson on the Line, by J. M. Oliver, Georgia Power Co. Joint meeting with the A. S. M. E., attended by students from the Georgia School of Technology. November 24. Attendance 325.

Baltimore

Engineering and Unemployment, by E. C. Stone, Duquesne Light Co., and Vice-President District No. 2, A. I. E. E. Dinner in honor of the speaker preceded the meeting. November 21. Attendance 27.

Boston

Louisiana Power Station of the Louisiana Steam Products, Inc., by Messrs. Weterer, C. R. Stewart, W. L. Locke, and H. J. Klotz. All the speakers are affiliated with Stone & Webster, Inc., and each told of the problems and special features of design that he encountered building this station in the record time of six and one-half months. November 18. Attendance 160.

Cincinnati

The Design and Characteristics of Induction Motors, by Mr. Carter, Allis Chalmers Mfg. Co. This talk included analysis of various designs and examples of their application in industry. General discussion followed. Dinner preceded the meeting. October 9. Attendance 53.

The Use of Electric Industrial Trucks, by C. B. Crockett, Industrial Truck Association. M. R. Berry, Electric Products Co., discussed truck batteries and charging methods. Three reels of motion pictures of electric truck application in large industries were shown. Following the talks, there was considerable discussion on such subjects as truck sizes, maintenance costs, power requirements, battery life, etc. Dinner in honor of the speakers preceded the meeting. November 13. Attendance 80.

Cleveland

High-Voltage Phenomena, by A. O. Austin, Ohio Insulator Co. Preceding this talk, Mr. Austin gave a series of demonstrations of artificial lightning, which he explained in some detail. E. L. Cove, Chief Engineer of Station WHK, gave a short talk on the advisability of insulating radio towers. He explained the advantages of such insulation and described the tests that were being conducted between Station WHK and Station WABC. October 16. Attendance 191.

The Electrical Features of the New Cleveland Terminal, by H. W. Pinkerton, Cleveland Union Terminals Co. Illustrated with slides and motion pictures. H. G. Leavell, Cleveland Electrical League, demonstrated the various lighting effects which can be obtained in their new auditorium. F. W. Braund, Chairman, gave a short résumé of the Summer Convention at Toronto last June. November 20. Attendance 160.

Connecticut

The Electrical Industry and Electrical Engineering in Russia, by A. Dovjikov, Westinghouse Electric & Mfg. Co. Meeting held at Dunham Laboratory, Yale University. November 11. Attendance 100.

Denver

Aerial Tramways, by Fred C. Carstarphen, Consulting Engineer, illustrated by lantern slides and moving pictures. November 21. Attendance 30.

Detroit-Ann Arbor

Lightning Investigations, by H. P. Seeyle, Detroit Edison Co., and J. R. Eaton, Consumers Power Co. Illustrated with slides. Discussion followed. November 18. Attendance 250.

Erie

Annual banquet and ladies' night. Lights of Home, by Ralph W. Shenton. Short address by E. C. Stone, Vice-President, District No. 2, A. I. E. E. Nate Harrington acted as stunt master. Members of the Technical Federation of Erie attended. November 18. Attendance 120.

Fort Wayne

Conduction, Convection, and Radiation of Heat in Electrical Machinery, by Professor A. D. Moore, University of Michigan. November 20. Attendance 100.

Houston

The Aid of the Automatic Telephone in Power Dispatching, by W. B. Hardin, Southwestern Bell Telephone Co. P. N. Underwood outlined the progress made in power transmission over a number of years. Following the the above talks those present visited the dispatching room of the above company, where the system was thoroughly explained and demonstrated. November 25. Attendance 30.

Indianapolis-Lafayette

Moving the Indiana Bell Telephone Company's Headquarters Building, by Vance Oathout, Indiana Bell Telephone Co.;

Latest Developments in Television, by Professor R. H. George, Purdue University. Also two films presented as follows: "Blasting the Water Highways of America," and "Hydroelectric Developments in the New South." Joint meeting with the Indiana Section of the American Radio Relay League. Dinner preceded the meeting. November 29. Attendance 105.

Los Angeles

F. E. Weymouth, Metropolitan Water District, gave an illustrated lecture concerning the proposed routes for the aqueduct through which the supply of water for Southern California from the Colorado River is to be effected. General discussion followed. Joint meeting with the A. S. C. E., the A. S. M. E., and A. I. M. E. November 12. Attendance 402.

Louisville

Meeting held to discuss plans for the District Meeting at Louisville. November 12. Attendance 40.

Memphis

The Electrification of Dredges, by C. T. Pearce, Westinghouse Elec. & Mfg. Co. R. H. Maxwell, of the same company, demonstrated the Grid-Glow Tube, Photoelectric Cell, and accessory equipment. November 12. Attendance 35.

Mexico

Annual banquet at which the officers for the year 1930-1931 were announced and introduced. November 22. Attendance 53.

Nebraska

Modern Practise of Laying Underground Long Distance Cables, by F. J. Rupe, Northwestern Bell Telephone Co., illustrated with moving pictures showing construction work in progress. November 21. Attendance 40.

Niagara Frontier

Mercury Arc Rectifiers, by Othmar K. Marti, American Brown Boveri Co., illustrated with slides. Motion pictures describing the mining, smelting, refining and rolling of the metal were presented. November 21. Attendance 60.

Oklahoma City

The World Power Conference at Berlin, Germany, by Dean P. S. Donnell, Oklahoma A. & M. College, illustrated with a number of slides made from pictures taken while visiting Europe. Film—"The New Hydroelectric Generating Station at Louisville, Ky." October 30. Attendance 115.

Illumination, by A. E. Warner, Oklahoma Gas & Electric Co.;

The Installation and Operation of Underground Toll Cable, by M. L. Olsen, Southwestern Bell Telephone Co. Illustrated with four films showing the actual installation of several underground toll cables in the southwest. November 24. Attendance 82.

Philadelphia

Some Recent Research Developments, by E. L. Manning, General Electric Co. November 10. Attendance 200.

Pittsburgh

Modern Physics, by Saul Dushman, General Electric Co. Moving pictures preceded the presentation of this paper. Joint meeting with the Engineers' Society of Western Pennsylvania. November 12. Attendance 324.

Pittsfield

Recent Developments in Steam Turbines, by H. L. Wirt, General Electric Co. Illustrated with slides. Dinner preceded the lecture. November 18. Attendance 120.

India—Present Condition and Future Outlook, by Professor S. L. Joshi, Dartmouth College. Dinner preceded the meeting. December 2. Attendance 550.

St. Louis

Dance. November 15. Attendance 132.

San Antonio

The Development of Radio Broadcasting, by J. Cummings, Manager of WOAI Broadcasting Station. Following the meeting those present inspected Station WOAI and Mr. Cummings gave brief explanations of the functions of each part of the station apparatus. November 17. Attendance 68.

San Francisco

Telegraphing Today, by M. V. Merriman, Western Union Telegraph Co. Miscellaneous apparatus, consisting of relays and parts from the various equipment used in telegraph, on display. Following the meeting the members were conducted through the main office of the Western Union Telegraph Co. The exchange was in full operation and all had an opportunity of witnessing the various activities as they normally take place. November 28. Attendance 90.

Saskatchewan

Some Recent Developments in Transformer Design, by C. E. Sisson, Canadian General Electric Co., and Vice-President District No. 10, A. I. E. E. Illustrated with a number of lantern slides. October 20. Attendance 22.

Seattle

Some Fundamentals of Illumination—Old and New, by Professor F. A. Osborn, University of Washington. Two moving pictures followed. A report of the Summer Convention held in Toronto last June was presented by L. N. Robinson, who was the delegate of the Section. November 18. Attendance 60.

Sharon

Semi-Annual Winter banquet meeting. Humor—A Mental Cocktail, by Dr. John L. Davis. December 2. Attendance 180.

Spokane

Spokane River Flow Control for Economic Operation of Hydroelectric Plants, by John A. Tobyn, Washington Water Power Co.;

Motors and Their Application, by Henry L. Vincent, General Electric Co. A report of the Summer Convention at Toronto last June was given by Earl Baughn, who was the delegate of the Section. November 21. Attendance 25.

Springfield

A Mechanical Analogy to the Problem of Transmission Stability, by A. D. Dovjikov, Westinghouse Elec. & Mfg. Co. Refreshments served after the meeting. November 10. Attendance 54.

Toledo

Metal-Clad Switch-Gear, by H. V. Nye, Allis Chalmers Mfg. Co., illustrated with slides. E. B. Featherstone presented a film "A Tourist Trip Through The Rockies," and explained the scenes as they appeared. November 14. Attendance 70.

The Transmission of Personality, by L. S. O'Roark, Bell Telephone Laboratories, Inc. Dinner meeting of the Affiliated Technical Societies of Toledo. December 4. Attendance 275.

Toronto

Copper Mining, Smelting, and Manufacture, by G. S. Mallett, American Brass Co. Moving pictures describing the mining, smelting, and fabricating of copper were presented. November 14. Attendance 88.

Planning to Meet the Development of the Systems of the Hydroelectric Power Commission of Ontario, by A. H. Frampton, H. E. P. C., illustrated with slides. November 28. Attendance 83.

Urbana

The Universe as a Physical Laboratory, by Professor R. H. Baker, Head of the Department of Astronomy, University of Illinois. November 18. Attendance 30.

Utah

Domestic Electric Water Heating, by H. M. Ferguson, Utal Power & Light Co. Informal dinner preceded the meeting. November 10. Attendance 40.

Washington

The Work of the American Engineering Council, by L. W. Wallace, American Engineering Council. Dinner preceded the meeting. November 11. Attendance 46.

Worcester

Construction and Maintenance of the 15 Mile Falls Development of the New England Power Company, by C. R. Olliver, illustrated with slides. November 13. Attendance 60.

Past Branch Meetings

University of Akron

Deion Circuit Breakers, by Mr. Seified, Student. Professor J. T. Walther, Counselor, and H. Shively, Chairman, outlined the activities at the District Meeting held in Philadelphia. October 30. Attendance 11.

Transmission Problems on Long Lines, by Troy Starr, American Tel. & Tel. Co. November 21. Attendance 11.

University of Arkansas

Railway Electrification, by G. V. Smith, Student;

Television, by Robert Hunt, Student. An automatic relay was presented to the school by Wylie Head, who had received it as a trophy of his summer work with the Westinghouse Elec. & Mfg. Co. November 5. Attendance 24.

Armour Institute of Technology

Radio as an Aid to Police, by W. P. Hilliard, Chicago Police Department. Joint meeting with the Armour Radio Association. November 17. Attendance 89.

Discussion on Submarine Tele-

Phones and Telegraph Cables, by Donald M. Detterman, Student;

High-Frequency Radio Beam Transmission, by Morton Fagen, Student. December 1. Attendance 51.

University of British Columbia

The Cathode Ray Oscillograph, by E. Crawford, Student;

Mercury Arc Rectifiers, by Mr. Thomas, Student. November 18. Attendance 17.

Inspection trip to the Ruskin hydroelectric plant of the British Columbia Electric Railway. November 21. Attendance 22.

Polytechnic Institute of Brooklyn

Electrodynamometers for Power Measurement, by T. C. Katsigris, Hub Engineering Corp;

Photelectric Cells, Their Construction and Uses, by R. T. Orth, Radio Corporation of America;

Lightning on Transmission Lines, by Prof. V. Karapetoff. Refreshments were served after the meeting. November 10. Attendance 64.

Bucknell University

Conowingo Hydroelectric Development on the Susquehanna, by C. M. Deatherage, Student;

The Philadelphia Plant of the General Electric Co., by Leighton Herbst, Student. O. R. Sterling, Chairman, outlined the activities of the Institute. November 10. Attendance 12.

California Institute of Technology

The Electrical Equipment of the New Astro-Physics Laboratory, by Emmett M. Irwin, Student. Luncheon preceded the meeting. November 20. Attendance 40.

University of California

After a short business meeting the following papers were presented:

Power, by A. H. Markwart, Pacific Gas & Electric Co.;

Hydroelectric Power Developments in California, by Robert W. Hollis, Student. November 19. Attendance 69.

Business meeting followed by the presentation of two films, as follows:

"The Steel Needle," and "Conquering the Cascade." New officers were announced and introduced. December 3. Attendance 25.

Catholic University of America

Election of officers as follows: David F. Doody, Chairman; C. R. Liekweg, Vice-Chairman; F. D. Vezzosi, Secretary-Treasurer. Professor T. J. MacKavanagh, Counselor, gave a talk on the activities of the Institute. October 11. Attendance 30.

The Photoelectric Cell and Its Applications in Industry, by D. F. Doody, Student. November 11. Attendance 30.

Clarkson College of Technology

Lecture on Photography, by Assistant Professor W. A. Dart, illustrated. Committee reports presented. November 11. Attendance 13.

Inspection trip to the Alogonquin Paper Corporation's Mill at Ogdensburg, N. Y. November 12. Attendance 51.

Clemson College

Inspection trip to the Saluda River Hydroelectric Power Plant. October 22. Attendance 35.

General Power Applications, by A. T. Vick, Student;

Two-Way Television, by H. C. Woodson, Student;

Current Events, by C. B. Stevens, Student; November 20. Attendance 26.

Report of the District Meeting in Louisville, by C. E. Jarrard, Student;

Current Events, by Joe Vance, Student. December 4. Attendance 30.

Colorado Agricultural College

Electrification of Rural Districts, by Mr. Stanbaugh, Public Service Co. of Colorado. November 24. Attendance 18.

University of Colorado

Rambles Through the Rockies, by Eben Fine. Illustrated. November 19. Attendance 30.

The Community and the Engineer, by Herbert S. Sands, President, Denver Chamber of Commerce. Professor Frank A. Eastom gave a short talk on the Summer Convention in Toronto last June. Professor Charles M. McCormick discussed the meetings held by the Denver Section. December 3. Attendance 35.

Cooper Union

Film—"The Theory of Construction and Operation of Electrical Instruments." November 19. Attendance 60.

Cornell University

Radio Beacon, by H. B. Simpson, Student;

Public Address Systems, by A. C. Stallman, Student;

Calculating Boards, by P. J. Glaister, Student;

The Charles Huntley Generating Station, by L. A. Eggelston, Student. December 3. Attendance 30.

Drexel Institute

Demonstration and Explanation of the Theremin, by Fred Farrow, Radio-Victor Corp. November 25. Attendance 60.

Duke University

L. R. Ransom, President, outlined the purposes and aims of the Institute. A. L. deBruyne elected Secretary. October 5. Attendance 17.

The Photoelectric Cell and Some Applications, by Russell Ransom, President;

Television and Recent Developments in that Field, by Stanley G. Flack, Student;

The Condenser Microphone and the Theory of It, by A. L. deBruyne, Secretary. Professor W. J. Seeley, Counselor, urged all to take an active part in the A. I. E. E. activities. October 16. Attendance 30.

Mercury Arc Rectifiers, by C. F. Brethal, Student. October 30. Attendance 10.

Illumination, by R. L. Peppell and W. F. Weaver, Students. November 13. Attendance 18.

University of Florida

A Trip through the Inglis Power Plant of the Florida Power Corporation, by J. L. Wolcott, Student;

A Modern Explanation of the Ohm's Law, by J. L. Sanders, Student. Film—"Hydroelectric Power Production in the New South." November 17. Attendance 22.

Reports of the recent District Meeting held in Louisville were given by Professor Joseph Weil, Counselor, and C. V. Booth, Chairman. December 3. Attendance 37.

Georgia School of Technology

Steam-Turbine Developments and Principles of Operation, by P. C. Eppelshimer, Westinghouse Elec. & Mfg. Co. November 12. Attendance 71.

Inspection trip to Plant Atkinson of the Georgia Power Company. Joint meeting with the A. I. E. E. and A. S. M. E. Sections. November 24. Attendance 100.

Harvard University

The Fifteen Mile Falls Hydroelectric Development, by E. W. Dillard, New England Power Construction Co., illustrated with lantern slides and motion pictures. November 13. Attendance 180.

State University of Iowa

The Automatic Garage, by Mr. Colony, Student;

Telephones in the Rough, by Mr. Cutler, Student;

Sound Reproduction, by Mr. Duckett, Student. November 19. Attendance 29.

Practical Uses of the Photoelectric Cell, by Mr. Fitzgerald, Student. Professor Edwin Kurtz, Counselor, and J. W. Campian, Chairman, gave reports of the Conference on Student Activities held in Chicago. December 3. Attendance 33.

Kansas State College

Success, by Professor L. M. Jorgenson. Professor R. G. Kloeffler, Counselor, gave a talk outlining the purposes and aims of the A. I. E. E. Entertainment and refreshments followed. October 24. Attendance 180.

Current Events, by S. W. Graham, Student;

Opportunities in Public Utility Work, by Paul Ayers, Student;

Television, by Mr. Burgin, Student. Moving pictures on the subject of X-rays presented. (Afternoon session.) October 30. Attendance 54.

The program of the evening meeting was the same as that presented in the afternoon. October 30. Attendance 53.

Current Events, by W. Tolley, Student;

Photoelectric Cells and Their Applications, by K. D. Cornell, Student;

L. E. Baldwin, Kansas Power & Light Co., gave a talk on public utility work and its functions, and also the possibilities for college graduates with these companies. Film—"Thomas Edison." (Afternoon session.) November 6. Attendance 56.

The program of the evening meeting was the same as that presented in the afternoon. November 6. Attendance 55.

University of Kansas

Television, by C. B. Brown, Student. Demonstrated.

Reports of inspection trips to Keokuk, Chicago, Milwaukee, and other cities by several students. November 13. Attendance 77.

Some Mechanical Engineering Problems in a Modern Oil Refinery, by W. L. Mathews, Standard Oil Co.;

Some Construction Details of an Industrial Power Plant, by C. O. Boynton, Standard Oil Co.;

Toll Telephone Plant Construction, by J. H. Schweitzer, Southwestern Bell Telephone Co., illustrated with slides;

Economic Design of Inter-City Communication Facilities, by L. F. Burwick, Southwestern Bell Telephone Co. Joint meeting of the Kansas City Sections and Univ. of Kans. Branches of the A. I. E. E. and A. S. M. E. December 4. Attendance 175.

University of Kentucky

Power of the East River Generating Station, by C. O. Fury, Student;

Power of the Pacific Light and Power Company, by F. Y. Carter, Student;

Membership Qualifications, Grades, and Entrance Requirements of the A. I. E. E., by Professor W. E. Freeman, Counselor. October 18. Attendance 41.

Scientific Aspects of Thomas Jefferson's Life, by Professor W. S. Rodman, Vice-President, District No. 4, A. I. E. E. November 17. Attendance 45.

Nitrogen Fixation Process, by S. H. Wise, Student;

W. O. Richmond, Student, gave a summary of a new method of removing water from the tanks of submarines. December 3. Attendance 41.

Lehigh University

Applying an Engineering Education, by H. G. Harvey, Associated Gas & Electric Co.;

The Screen-Grid Radio Circuit, by L. R. Wanner, Student. Paul W. Seal, Chairman, outlined the proposed program for the coming year; also the aims and activities of the A. I. E. E. November 7. Attendance 100.

Lewis Institute

Your Chicago, by T. Price, Commonwealth Edison Co., illustrated with moving pictures. December 5. Attendance 76.

Marquette University

Short papers read by several students. November 13. Attendance 22.

Massachusetts Institute of Technology

The Generation and Distribution of Electric Power, by E. S. Mansfield, Edison Electric Illuminating Co. of Boston. Film—"More Power To You." November 20. Attendance 230.

Inspection trip to the Milk Street Manual Exchanges and the Kenmore Automatic Exchanges of the New England Telephone & Telegraph Co. December 3. Attendance 30.

Michigan College of Mining and Technology

Motor Maintenance and General Maintenance of Electrical Equipment, by Mr. Zimmerman, Westinghouse Elec. & Mfg. Co. Committees appointed to take care of the arrangements for the Electrical Show to be held next May. November 7. Attendance 61.

The Student Training Course at Westinghouse, by M. D. Crowell, Secretary. November 19. Attendance 29.

James Rowley, Student, outlined his experiences with the Detroit Edison Co. during the past summer. December 3. Attendance 25.

University of Michigan

What Does an Engineer do in a Manufacturing Plant, and How? by A. M. Dudley, Westinghouse Elec. & Mfg. Co. November 12. Attendance 100.

The Production of Electric Power, by A. R. Smith, General Electric Co. November 18. Attendance 110.

School of Engineering of Milwaukee

The Water Supply of Muncipalities and the Selling of Water Supply Equipment, by E. Roger, Layne-Northwest Pump Co. Refreshments served. November 12. Attendance 150.

Missouri School of Mines and Metallurgy

The Effect of Electricity upon the Nervous System, by J. E. Stokes, Student;

My Summer Experiences, by A. R. Baron, Student. November 19. Attendance 21.

My Summer Experiences, by J. D. Shelton, Chairman. December 3. Attendance 13.

University of Missouri

Design of Alternators, by J. W. Logan, Student. November 12. Attendance 57.

Montana State College

A Small Motor with a Low Starting Current, taken from the *Electric Journal*, presented by Wesley C. Funk, Student;

A New Portable Oscillograph, taken from the A. I. E. E. Journal, presented by Manley Goldberg, Student;

The Development of the Modern X-Ray Generating Apparatus, taken from the *General Electric Review*, presented by N. Grebeldinger, Student. November 6. Attendance 147.

Electricity vs. Steam, taken from *World's Work*, presented by Arthur Sheldon, Student;

Short Cuts in Mathematics, by Walter Williams, Student;

A Portable Emergency Local Distribution Substation, taken from the *General Electric Review*, presented by Harry Beck, Student;

Scheduled Speed Increased by Electrification, taken from the *Electric Railway Journal*, presented by Howard Freeman, Student. November 13. Attendance 145.

N. E. L. A. Electrification Report, taken from *Railway Age*, presented by Vern Hankins, Student;

Radio now has Tone Control, taken from *Popular Science Monthly*, presented by Curtis Hanson. November 20. Attendance 146.

University of Nebraska

What I would do if I were a Senior now, by F. J. Gunther, Iowa-Nebraska Light & Power Co. December 3. Attendance 30.

Newark College of Engineering

Electrification of the Lackawanna, by Edward Anson, Jackson & Moreland;

Development of Mercury Arc Rectifiers, by W. R. Ackor, Chairman, illustrated. November 17. Attendance 41.

University of New Hampshire

Retox Rectifiers, by Marshall E. Bowker, Student;

Multiplex Printers, by Arthur G. Pinkham, Student. October 18. Attendance 34.

Film—"Power Transformers." November 15. Attendance 33.

Theory of Corona Loss in Power Transmission, by C. G. Matoian, Student;

Demonstration of the Left-Hand Motor Rule, by R. E. Sawyer, Student;

Horn-Gap Lightning Arrester, by A. G. Pinkham, Student. L. E. Potts and L. E. Moore, Students, demonstrated the above with high-voltage apparatus, and conducted a few other experiments with the same apparatus. November 22. Attendance 24.

Some Hydroelectric Developments in New Hampshire and Vermont, by P. E. Rolfe, Student;

Manufacture and Uses of Carborundum, by L. A. Barker, Student;

Sparking in a Partial Vacuum, by M. H. Riley, Student. November 29. Attendance 30.

University of New Mexico

The Radio Knife, by C. E. Henderson, Chairman. November 13. Attendance 15.

New York University

Debate—Resolved: That water power in New York States be Owned, Operated, and Distributed by the State. November 10. Attendance 21.

Tying Up of Power Networks, by C. J. Ridgley, Student. November 24. Attendance 14.

North Carolina State College

Review of the Life of Steinmetz, by C. M. Smith, Student;

Railroad Signaling, by J. W. Sutherland, Student. November 18. Attendance 31.

A report of the District Meeting held at Louisville was given by R. C. Kirk, Chairman. December 2. Attendance 30.

North Dakota State College

Film—"Power." November 20. Attendance 85.

Film—"From Coal to Electricity." December 4. Attendance 52.

University of North Dakota

A New Screen-Grid Tube, by William Denk, Student;

William Spriggs and A. W. Eynon, Students, gave a practical demonstration of the current-illumination characteristics of the photoelectric cell, and also its color sensitivity. November 12. Attendance 18.

Northeastern University

Electrical Units, by Dr. A. E. Kennelly, Harvard University. Refreshments served. November 4. Attendance 89.

University of Notre Dame

The Street Lighting System of South Bend, Indiana, by Frank Mills, Indiana Michigan Electric Co.;

Starting and Reversing Single-Phase Induction Motors, by John Staunton, Student;

High-Frequency Induction Furnaces, by A. White, Student;

Patrick Murray, Student, presented the regular digest of engineering news. November 17. Attendance 73.

Ohio Northern University

The Effect of Electric Shock, by J. M. Stewart, Student. November 20. Attendance 33.

Ohio University

Films as follows: "Beyond the Microscope," "Pillars of Salt," and "The Continuous Process of Making Sheet Steel." November 17. Attendance 12.

Oklahoma A. & M. College

Construction and Care of Transformers, by W. E. Nichols, Student;

Evolution of the Transformer, by Hubert Short, Student, illustrated with slides. November 20. Attendance 10.

Oregon State College

General discussion of Branch activities. November 10. Attendance 55.

Electric Power from Hogged Fuel and the Relation of Steam to Water Power Plants, by C. P. Osborne, General Electric Co., illustrated with slides. Films—"Blasting the Water Highways of America," and "Hydroelectric Power Production in the New South." November 19. Attendance 38.

Pennsylvania State College

Smoker and Annual Get-Together. October 8. Attendance 91.

Talks by five Students on their summer experiences. October 29. Attendance 38.

Film—"From Mine to Consumer." November 5. Attendance 53.

The Development Engineer in Manufacture, by D. Levinger, Western Electric Co., illustrated with slides and motion pictures. November 18. Attendance 93.

University of Pennsylvania

Motion pictures. December 5. Attendance 26.

University of Pittsburgh

Lightning, by R. G. Woessner, Student;

H. K. Aalborg, Student, related his experiences as circuit breaker engineer while employed by the Westinghouse Electric & Mfg. Co. October 9. Attendance 116.

Transoceanic Communication, by R. A. White, Student;

D. N. Burdette, Student, outlined the design and operation of magnetic strain gages as developed by the Westinghouse Electric & Mfg. Co. October 16. Attendance 110.

Biography of Faraday, by Robert Canning, Student;

D. W. Burns, Student, outlined some early developments in electricity. October 23. Attendance 109.

Modern Railways, by C. I. Staples, Westinghouse Elec. & Mfg. Co. Movies, refreshments, and entertainment followed. October 30. Attendance 85.

H. J. Stoneman, Student, described the operation of the West Penn Power Company's Coal Mine at Springdale;

W. J. Wherry, Student, outlined the manufacture of rubber as carried on at Akron, Ohio. November 6. Attendance 113.

Modern Electric Refrigeration, by A. J. Mattes, Student;

F. A. Mallisee, Student, traced the historical development of all types of meters. November 13. Attendance 113.

Development of Transmission Lines, by L. A. Terben, West Penn Power Co. November 20. Attendance 118.

Pratt Institute

Panel Boards, by L. Johnson, Student;

Railroad Control and Railway Signaling, by C. Schimke, Student. November 13. Attendance 30.

Westinghouse Test, by John Cook, Student. December 3. Attendance 50.

Princeton University

Election of officers as follows: Frank L. Thomson, Chairman; E. E. George, Secretary. December 4. Attendance 13.

Purdue University

Lecture on the Magnetic-Type Oscillograph, by Professor G. V. Mueller;

New Permanent-Magnet-Type Oscillograph, by D. A. MacAffer, General Electric Co. November 20. Attendance 125.

Rensselaer Polytechnic Institute

Description of the Emmet Mercury Vapor Process equipment installed by the General Electric Co. in the South Meadows station of the Hartford Electric Co., by James Orr of the same company. November 11. Attendance 285.

Rhode Island State College

Film—"Buried Sunshine." November 24. Attendance 30.

Business Meeting. December 8. Attendance 7.

Rose Polytechnic Institute

Film—"A History of the Electrical Industry." November 24. Attendance 37.

Lifting Magnets, by Mr. Richardson, Student

Robert Roach, Student, gave a report of the Conference on Student Activities held in Chicago. December 5. Attendance 34.

Rutgers University

Recent Developments in the Bell System, by Mr. Birch, Student;

Opportunities for Employment in the Bell Laboratories, by Mr. Wolff, Student. October 28. Attendance 22.

Rubber-Covered Cables, by Milton Trompen, Student;

Film—"The Single Ridge." November 11. Attendance 25.

Kenotron and Thyratron Tubes, by Jacob Rudnitsky, Student;

Rotary Converters, by Fred Kent, Student;

Comments on Mercury Arc Rectifiers, by Prof. Pumphries. November 24. Attendance 19.

Santa Clara University

Films"—Hydroelectric Water Tunnels," and "Channel Excavations." November 5. Attendance 31.

Survey of Aeronautics, by Walter Van Haitsma, Boeing Aircraft Co. November 19. Attendance 63.

Oil Circuit Breakers, by Roy Wilkins, Pacific Electric Mfg. Corp., illustrated with slides. November 19. Attendance 40.

Inspection trip to Station A—Pacific Gas & Electric Co. Generating Plant. November 24. Attendance 39.

University of South Carolina

The Deion Circuit Breaker, by H. L. Stokes, Chairman. Film—"Hydroelectric Power Production in the New South." November 17. Attendance 34.

The Engineer's Outlook on Life, by S. Hammon. Professor T. F. Ball, Counselor, and H. L. Stokes, Chairman, outlined the events at the District Meeting held in Louisville. November 24. Attendance 30.

Business Meeting. December 1. Attendance 9.

South Dakota State School of Mines

Needed Improvements in Distribution Systems, by Lee Boyer, Consolidated Power & Light Co. Stanley Sickle and Clifford Spilker, Students, outlined their experiences during the past summer on construction work with the American Tel. & Tel. Co. November 19. Attendance 34.

University of Southern California

Lecture on The Trails of the High Sierra, by Professor N. C. Clark, illustrated. November 29. Attendance 45.

Lecture by Professor N. C. Clark on the region near and including Yosemite Valley. November 5. Attendance 37.

Films—"Blasting the Water Ways of America," and "Hydroelectric Power Production in the New South." November 12. Attendance 34.

Industrial Lighting, by Willard Bausman, Holophone Illuminating Co. November 19. Attendance 31.

Blind Landing of Aeroplanes, by Walter Weis, Student. December 3. Attendance 25.

Southern Methodist University

Professor H. F. Huffman, Counselor, outlined the aims and activities of the Institute. Election of officers as follows: F. H. Gable, Chairman; I. Frauman, Vice-Chairman; Porter Lindsley, Jr., Secretary-Treasurer. October 15. Attendance 37.

Underground Distribution System of the Dallas Power & Light Co., by H. H. Robinson of the same company. Illustrated. November 12. Attendance 30.

Demonstration of a Short-Wave Sending Set, by D. J. Tucker, Student;

Demonstration of a Thermocouple, by R. L. Allen, Jr.;

Laboratory Experiments with Transformers, by Carlos Burnett, Student. Joint meeting with the Dallas Section. November 17. Attendance 80.

Stanford University

E. A. Crellin, Vice-Chairman, San Francisco Section, A. I. E. E., discussed plans for closer relationship between the Branches and the Section. Professor T. H. Morgan, Counselor, outlined the new by-laws concerning Student enrolment. October 21. Attendance 17.

Aeronautical Radio Communication, by Eugene Sibley, reviewed by Robert Triplett, Student;

Relay Metering, by D. A. Murray;

A New System of Speed Control for A-C. Motors, by A. M. Rossman, reviewed by V. Siegfried, Chairman;

G. S. Kimball, Student, described the new equipment being installed in the Electrical Engineering Laboratory. November 25. Attendance 15.

Syracuse University

Trolley Buses, by E. W. Schweitzer, Student;

Automatic Train Control, by D. W. Phelan, Student. November 14. Attendance 25.

Recording of Sound Pictures, by M. J. Kraska, Student;

Airport Lighting, by C. R. Anderson, Student. Illustrated. November 21. Attendance 25.

Two illustrated lectures presented as follows: The Evolution of the Transformer, and 50,000 Kv-a. Synchronous Condensers. December 5. Attendance 25.

University of Tennessee

Get-Together Meeting. December 2. Attendance 52.

Texas A. & M. College

Electric Shock, by H. A. Eddins, Student;

Resuscitation from Electric Shock, by J. A. Shellberg, Student. November 11. Attendance 60.

Texas Technological College

Dean W. J. Miller, Counselor, and Walter Burns, Chairman, outlined the aims and purposes of the Institute. Committee appointments announced. October 8. Attendance 19.

Film—"The Conowingo Hydraulic Dam." November 7. Attendance 14.

The Adapting of Electricity to Railroads and Large Ships, by Wm. Walker, Student;

Tuco (a large generating plant which is nearing completion), by Hubert J. Allen, West Texas Utility Co. November 19. Attendance 50.

Inspection trip to the new power plant of the Texas Utility Co. November 25. Attendance 35.

University of Texas

Boiler Feed-Water Control, by C. A. Glover, Student. November 13. Attendance 18.

University of Utah

New Developments in Hydroelectric Plants, by L. E. Painter, Student;

The Relationship between the Big Open Air Mine at Bingham, Utah, and Electricity, by Ray Bohne, Student. October 28. Attendance 21.

Film—"From Mine to Consumer." December 2. Attendance 24.

University of Vermont

Westinghouse Method of Frequency Control, by P. H. Thomas, Student;

The Selsyn Motor, by M. L. Joslin, Student. November 18. Attendance 27.

Films as follows: "Blasting the Water Highways of America," "Building New York's Newest Subway," "Driving the Cascade Tunnel," and "Hydroelectric Power Production in the New South." Joint meeting with the A. S. M. E. December 3. Attendance 60.

Virginia Military Institute

Improved Lighting on Our Highways, by Mr. Ould, Student;

Industry's Tribute to George Westinghouse, by Mr. Woodson, Student;

Railroad Electrification, by Mr. Moore, Student;

The Talking Picture Apparatus in J. M. Hall, by Mr. Stokes, Student;

Low Cost of Construction, by Mr. Welch, Student. October 16. Attendance 47.

An account of the activities of the District Meeting held in Louisville was given by C. G. King, representative of the Branch. December 4. Attendance 47.

Virginia Polytechnic Institute

Professor C. Lee, Counselor, and R. E. McDaniel, A. B. Pritchard, and E. L. Rowell, Students, outlined the activities of the District meeting held in Louisville. November 25. Attendance 17.

Steinmetz, by R. C. Hoffman, Student;

Sound Reproduction, Western Electric Method, by W. J. Pritchard, Student;

Economy and the Engineer, by C. V. Burgess, Student. Professor C. Lee, Counselor gave a talk on some of the activities of the Institute. December 4. Attendance 42.

University of Virginia

Development of Short-Wave Radio Communication, by W. B. Campfield, Student;

Development of Broadcast Radio, by G. B. Miller, Student. Short talk by Professor W. S. Rodman, Counselor. November 7. Attendance 16.

Washington State College

Film—"An Electrical Travelogue." November 12. Attendance 36.

Harry Skaglund, Student, outlined a trip he took to Diablo Dam, near Seattle, last summer. Committee chosen to make arrangements for the A. I. E. E. banquet. November 25. Attendance 16.

University of Washington

Switchboard Equipment, by James MacDougal, Roller Smith Co., illustrated with slides. November 6. Attendance 20.

The Power Company's Goat, by P. L. Morton, Student. November 13. Attendance 23.

Washington University

Radio Servicing, by Richard O. Denning, Student. November 6. Attendance 26.

Electrical Communications, by J. C. Rathman, Postal Telegraph Co. Film—"Under the Seven Seas." November 20. Attendance 17.

University of Wyoming

Rectifiers used in Radio Apparatus, by Floyd Wickencamp, Student;

Effect of Anti-Knock Compounds on Fuels Used in Internal Combustion Engines, by Vincent Bowles, Student. Joint meeting with the A. S. M. E. November 4. Attendance 17.

Electric Fish, by E. Hemenover, Student;

A New Method of Removing Scale and Corrosion from Steel, by J. Sillasen, Student;

Power from the Ocean, by C. Horton, Student. November 18. Attendance 11.

Yale University

Advantages and Disadvantages of Holding Corporations, by R. A. Hockley, Student;

Regulation of Holding Companies, by E. R. Eberle, Student;

The General Electric Unemployment Insurance Plan, by L. A. Autuori, Student. November 18. Attendance 13.

Power System Stability, by Professor G. C. Dahl, Massachusetts Institute of Technology. November 25. Attendance 42.

Employment Notes

Of the Engineering Societies Employment Service

Positions Available

SALES ENGINEER, who has had experience selling resistance units and rheostats for industrial and radio applications. Apply by letter giving experience in full. Headquarters, Middle West. W-2120.

◆

Men Available

ELECTRICAL ENGINEER, college graduate, good character. Approximately 13 years' practical experience divided as follows: 9 months' clerical work, 6 months maintenance and switchboard operating in high tension power plants, 12 years' detailed and general engineering of low voltage power plants. C-8328.

1930 GRADUATE ELECTRICAL ENGINEER, Rensselaer Polytechnic Institute. Ten months' experience with sound picture industry; five months' thesis experience investigating acoustics of broadcasting studio, miscellaneous experience servicing radio receivers. Location, New York City district. Available short notice. C-8407.

ELECTRICAL SUPERINTENDENT OR FOREMAN, 12 years' experience taking charge; can handle any size job or jobs. Sober, reliable and industrious. Best of references. C-8464.

1929 GRADUATE, American, E. E. degree: 14 months on General Electric Test Course. Interested in research; vacuum tube application work. Experience covers above, also testing all types of electrical equipment. C-1879.

ENGINEER, EXECUTIVE, B. S. degree; 20 years' experience in engineering, contracting and purchasing, desires permanent connection with large industrial company or as a local representative. Location, New York City. B-5050.

ELECTRICAL ENGINEER, 27. Experience includes: Westinghouse oscillograph operation; raw material inspection; pump, boiler and steam turbine tests; electrolysis survey of subway cables; electrical construction in finished buildings. Laboratory work preferred in Metropolitan area. C-8424.

GRADUATE ELECTRICAL MECHANICAL ENGINEER, 36, desires connection with public utility, industrial firm in power station operation as engineer, assistant to superintendent or engineer. Ten years' experience power plant test, operation, design, construction, maintenance. Three years electrical engineer for industrial concern. Two years assistant to power engineer. B-8379.

1930 GRADUATE ELECTRICAL ENGINEER, 22. Experience: six months in boiler-testing gang, three months testing centrifugal

ENGINEERING SOCIETIES EMPLOYMENT SERVICE

57 Post St.
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N. D. Cook, Manager

205 West Wacker Drive
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A. K. Krauser, Manager

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New York
W. V. Brown, Manager

MAINTAINED by the national societies of civil, mining, mechanical, and electrical engineers, in cooperation with the Western Society of Engineers, Chicago, and the Engineers' Club of San Francisco. An inquiry addressed to any of the three offices will bring full information concerning the services of this bureau.

Men Available.—Brief announcements will be published without charge; repeated only upon specific request and after one month's interval. Names and records remain on file for three months; renewable upon request. Send announcements direct to Employment Service, 31 West 39th Street, New York, N. Y., to arrive not later than the fifteenth of the month.

Opportunities.—A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

Voluntary Contributions.—Members benefiting through this service are invited to assist in its furtherance by personal contributions made within 30 days after placement on the basis of 1.5 per cent of the first year's salary.

Answers to Announcements.—Address the key number indicated in each case and mail to the New York office, with an extra two-cent stamp enclosed for forwarding.

water pumps, one year maintaining test equipment in radio receiver manufacturing plant. Prefers work in radio, sound reproduction, or communication; however, will be interested in other work. Location, preferred in or near New Jersey. C-8452.

ELECTRICAL ENGINEER AND EXECUTIVE, married; 20 years' experience in electric distribution and maintenance problems. Desires position in East or South with public utility company. Available immediately. C-7700.

ELECTRICAL ENGINEER, 28, single, B. S. in E. E. 1924. Six years' experience large public utility in utility economics including water power values, financial, load forecasts, power studies, studies of system development, rate studies, unit costs, research work, general matters of financial, economic nature; desires position, public utility, industrial concern. Location, preferably South. C-6985.

GRADUATE ELECTRICAL ENGINEER, 34, married, desires connection with future. Experienced in power and substation work, investigations, estimates, specifications, design and construction, control and relay work, related calculations, investigation of system conditions in connection with expansion and load additions. Industrial substations. Foreign languages. U. S. Citizen. Location, United States or Foreign. B-6560.

ENGINEER, with sales experience over a wide territory and experienced in electrical, mechanical and rubber industries in development laboratory and production. Offers his services. B-7829.

SALES ENGINEER, 27, single, graduate engineer. Engineering and sales experience of five years with leading control manufacturer. Desires position with sales department of an electrical concern or motor-control specialist for a fast growing electrical jobbing house. C-8390.

ELECTRICAL AND ILLUMINATING ENGINEER, 41, married; 23 years' experience, wireman to superintendent, estimator and engineer, instructor in applied electrical engineering in technical school. Experienced wiring power stations, commercial and industrial buildings. Five years' engineering for architects, writing specifications and designing electrical installations for office buildings, hotels, hospitals, industrial buildings. C-8460.

GRADUATE ELECTRICAL ENGINEER, 30. Two years' railroad shop and power plant experience, 4¾ years' large eastern railroad electrical engineer's office, drafting and design, appraisal electrical and power plant machinery, investigation and reports of engineering projects. Nineteen months electrician, U. S. Shipping Board diesel and diesel-electric motorships. Speaks Spanish. C-8160.

ELECTRICAL ENGINEER, 32, married, B. S. Nine years with large public utility. Six years power station and substation design and layout, including purchase of equipment and materials. Three years cable inspector and tester. Three years' practical field experience. Four years' clerical and executive experience. Location, Metropolitan, New York. B-3698.

ELECTRICAL ENGINEER, married, 35. Several years with design, construction corporation on electrical design, construction, starting up, and specifications, covering large power plants, industrial electric drives and auxiliaries. Several years with large manufacturer of electrical equipment, designer, switching, control, general engineer. Experience writing reports and some in technical paper writing. B-3172.

ELECTRICAL DESIGNER, age 38, married. Fourteen years' public utility experience, five different corporations, power plant, switching station, substation, both indoor and outdoor. Desires connection with public utility or industrial organization. Available now. Location preferred, East. C-8490.

RECENT GRADUATE ELECTRICAL ENGINEER, married, age 24. Location, Northern United States. Available now. C-7975.

ELECTRICAL ENGINEER, graduate Georgia Technology 1930, cooperative plan. Worked alternate months, five years substation maintenance and office.

GRADUATE ELECTRICAL ENGINEER, American, 31, married; eight years' public utility experience, hydroelectric developments, high-tension switching stations and distribution substations complete engineering design and supervision of several major developments in the United States and in South America; seeks permanent connections. Speaks German and Spanish. C-8470.

SALES ENGINEER, 33, married, Chilean Technical graduate, Westinghouse graduate students course. One year University of Pennsylvania; seven years of actual sales work in Mexico and Chile with Westinghouse. Speaks Spanish and English fluently. Desires location in utility or manufacturing company. Location, immaterial. Available immediately. C-8524.

GRADUATE, 1929 with B. S. in electrical engineering, 23, desires position with railway or public utility company. One year Westinghouse student course and has some diagram experience. Location, Middle West or Pacific Coast preferred. C-8523.

MECHANICAL-ELECTRICAL ENGINEER, with 15 years' experience in layout, construction and operation of industrial plants, seven years' design of power plants, five years' machine design, 2 years' machine shop practise, engineering college graduate. Desires position as engineer, chief draftsman or in similar capacity. Available immediately. B-2492.

GRADUATE ELECTRICAL ENGINEER, single, 31, solicits inquiries. Nine years' experience design of power stations, substations and industrial plants, also outdoor substations. Worked with Westinghouse in Pittsburgh and New York Edison Company. Speaks and writes German. Knowledge of French, Spanish. Will locate anywhere. Available immediately. First-class references. C-2522.

ENGINEER, ELECTRICAL, B. S.-E. E. Over 20 years' experience on power plants, substations and industrial plants. Ten years' experience on power plants, substations and industrial plants. Ten years' as designer and checker; ten years' as assistant electrical engineer, covering specifications, supervision of design, purchase of equipment, estimates, consultation, correspondence, etc. Available now. Will accept any reasonable offer. C-3785.

FIRST-CLASS TROUBLE SHOOTER wants work at once. Eight years in public utility and industrial plants. I. C. S. graduate in E. E. and associate A. I. E. E. C-8522.

RADIO ENGINEER, B. S. in E. E., 23, one year in general radio research laboratory. One year as design engineer with radio-receiver manufacturer. Desires position of similar character in laboratory of receiver manufacturer or allied electrical activity. C-8521.

TRANSMISSION AND DISTRIBUTION ENGINEER, desires position in tropical climate. Now superintendent of a tramway in City in Brazil. Experienced in transmission of Irish nationality, speaks Portuguese. Holds first-class diploma Foradoz House, Graduate I. E. E. C-8519.

ELECTRICAL ENGINEER, graduate Georgia Tech, 1930, cooperative plan. Worked alternate months, five years' substation maintenance and office engineering. Rebuilding transformers, switches, lightning arresters, work with electric furnaces, rectifiers, motors, etc. Checking and mapping distribution systems, work orders. Single, excellent physical condition. Desires position, preferably with public utilities. Location, immaterial. C-7847.

ELECTRICAL-MECHANICAL ENGINEER, executive; 23 years' diversified experience as an engineer and executive in industrial plant equipment and operation. Particularly successful in present connection along lines of mechanical plant improvement and in obtaining employee cooperation through personnel training. Can refer freely to each connection held. C-7839.

SUPERINTENDENT, married, 42; 20 years' experience in electrical construction of power plants, automatic railway substations and mercury arc rectifiers. Desires connection with public utility or large manufacturing company. Available because company discontinued construction. C-8520.

SUPERINTENDENT, general foreman or field engineer for construction company or utility, (electric, gas, or water) on construction, maintenance or operating. Young, energetic, ability and experience handling large crews and jobs of many details. Good organizer. B-9380.

ELECTRICAL ENGINEER, graduate Union College, 1924, age 28, married, good appearance, 15 months General Electric Test Course. Four years' public utility operation; 15 years' noncommercial radio experience. Location, East. Available at once. C-4182.

ELECTRICAL ENGINEER, B. S. degree, 33, Westinghouse sales course, 15 months sales assistant, three years technical advertising, four and one-half years development, sales, surveys on oil-electric locomotives. Executive ability. Desires sales position electric traction or industrial electrical equipment; or engineering with railroad electric-traction department. References. Location will consider. C-7545.

GRADUATE ENGINEER with strong theoretical background. Extensive practical experience in public relations, valuation, rate-making, special economic studies, investigations and research. Well qualified as a junior executive for large industrial or public utility corporation, or director of research special investigations or publicitiy. Now engaged as executive. Available on reasonable notice. C-6733.

GRADUATE ELECTRICAL ENGINEER, 34; power-house, railroad shop, steel-mill electric operation, repair and test experience; power-plant, substation, railroad electrification design; posted on economic and financial fundamentals and statistics; six languages. Valuable to management, financial, industrial organization. C-6952.

ELECTRICAL ENGINEER, 36, experienced in every phase of construction and maintenance (including South America), central stations, substations, inspections, tests, distribution systems, pole lines; one year operating. Desires position at home, or abroad, will represent manufacturer in Brazil; elsewhere considered. Languages, English, French, Portuguese, working knowledge Spanish, German, Italian. Best references. Available immediately. C-2021.

ADVERTISING-ELECTRICAL ENGINEER, 38, extensive and varied career, chiefly in executive capacities. Author of technical articles. Desires opportunity in advertising with either agency, publishing house or sales counsel. Initial salary secondary, where engineering background, wide acquaintanceship, originality, ability to analyze, and proper personality, may be capitalized. B-9079.

GRADUATE ELECTRICAL ENGINEER, B. S. degree, single, 24. Desires position along lines of design, development, or experimental work in industrial, railway electrification, or utility fields. Two years' General Electric test. Available now. Location, East or Middle West. C-4583.

ENGINEER, E. E. degree, age 30, married. Wide experience in layout, design and research of small electrical parts, radio, motion picture and sound system apparatus. Desires position in laboratory or drafting room. A-1 references. Available immediately. Location, New York. B-5138.

ELECTRICAL ENGINEER, 32, married. Nine years' general testing and development experience including railway equipment, with exceptional practical knowledge of power mercury arc rectifiers. Desires position in test or operating departments, of public utility or electric railroad, South, East or Chicago. C-7875.

ELECTRICAL ENGINEER, 36, single, European education, North Ameircan training, good executive, 9 languages. Eight years' experience construction, maintenance, operation large public utility plants. Seven years sales, various branches. Expert in exports and government supplies. Traveled over the world. Adaptable to any country, climate. Available now. Desires position abroad C-8351.

ELECTRICAL ENGINEER, 24, married. Desires engineering work. Has had experience with oscillographs and radio. Holds second grade commercial wireless operators license. Has public utility test experience. Also surveying experience. Personal interview desired. C-3035.

SALES AND EXECUTIVE ENGINEER, trained at Worcester Polytechnic Institute. Six years' sales experience; straight sales engineering, jobbing sales, sales promotion and management. Has contacted with electrical and mechanical companies. Traveled East, Middle West, South. Well acquainted with New England. C-5431.

GRADUATE ELECTRICAL ENGINEER, 26, one year's experience large public utility, power engineer, 1½ years research department large manufacturing company. Experienced, design of electromagnetic appliances. mechanical design and equipment layouts. Drafting experience. Best references. Ability to handle men. Desires connection, public utility, motor or industrial control manufacturing. Available two weeks' notice. C-7737.

ELECTRICAL-MECHANICAL ENGINEER with extensive and mature experience in the United States and foreign fields would like a connection where his knowledge and experience would be of most benefit, design, specifications, estimates construction, superintendence of operation power and industrial plants, engineering correspondence, engineering sales—whatever you need. C-408.

GRADUATE ELECTRICAL ENGINEER, age 29, married. Five years' practical experience construction and maintenance work. C-8539.

SUPERINTENDENT of distribution, 43, married. Electrical and industrial management. Twenty years' electric utility operating experience, in engineering, construction, operation, maintenance of distributing and transmission lines, substations, first aid and educational work. Has sufficient public utility operating experience to qualify for position of superintendent. Demonstrated record of executive ability. C-8411.

ELECTRICAL ENGINEER, graduate, E. E. degree, 28, married. Three years' experience, relays, relay studies large electric power and light utility, operating New York City. Three years' testing, design and development work on new electrical appliances and materials Experience includes considerable outside contact leading electrical manufacturers. Available immediately. Location, New York City. B-8793.

Membership

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Applications have been received by the Secretary from the following candidates for election to membership in the Institute. Unless otherwise indicated, the applicant has applied for admission as an Associate. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the Secretary before January 31, 1931.

Adams, E. C., Pacific Tel. & Tel. Co., Portland, Ore.
Allen, C. S., General Electric Co., Schenectady, N. Y.
Altstadt, A. O., T. M. E. R. & L. Co., Milwaukee, Wis.
Anderson, W. A., United Electric Lt. & Pr. Co., New York, N. Y.
Aranda, F. T., J. F. Azcarate S. en C., Mexico City, Mex.
Arzadon, F. S., 27 W. Superior St., Chicago, Ill.
Atkinson, F. W., General Electric Co., Schenectady. N. Y.
Atlee, Z., General Electric Co., Schenectady, N. Y
Baily, L. W., General Electric Co., Philadelphia, Pa.
Baker, R. A., Public Service Elec. & Gas Co. of N. J., Hackensack, N. J.
Barrett, W. J., (Member), N. J. Bell Tel. Co., Newark, N. J.
Basley, W. J., Jr., Southern New England Tel. Co., Stamford, Conn.
Beeman, D. L., General Electric Co., Philadelphia, Pa.
Belknap, M. M., Iowa Railway & Light Corp., Perry, Ia.
Berry, W. J., General Electric Co., Erie, Pa.
Bishop, S. J., American Tel. & Tel. Co., Hartford, Conn.
Bogdanowski, J. W., Brooklyn Edison Co., Brooklyn, N. Y.
Booth, D. M., Cia. Hydroelectrica Guanajuatense, S. A., Mexico City, Mex.
Borden, A. O., Portland General Electric Co., Portland, Ore.
Boyd, G. G., Public Service Co. of No. Ill., Evanston, Ill.
Bradford, H. E., Westinghouse Elec. & Mfg. Co., Sharon, Pa.
Bramhall, F. B., Western Union Telegraph Co., New York, N. Y.
Brant, T. J., Box 427, Whitby, Ont., Can.
Brazil, C., West Coast Power Co., Shelton, Wash.
Brotz, A. J., Howell Electric Motors Co., Howell, Mich.
Browne, H. L., (Member), Western Union Telegraph Co., New York, N. Y.
Browning, G. H., (Member), Doble Engineering Co.; National Co., Winchester, Mass.
Brune, O., Mass. Inst. of Technology, Cambridge, Mass.
Bugg, V. M., (Member), General Research Corp., New York, N. Y.
Burn, E. M., General Electric Co., Bridgeport, Conn.
Burner, G. I., Pennsylvania Railroad, Philadelphia, Pa.
Byrne, J. J., General Electric Co., Lynn, Mass.
Cameron, H. J., General Electric Co., Fort Wayne, Ind.
Cassidy, E. C., Reading Railroad Co., Philadelphia, Pa.
Cerow, J. A., Jr., Brooklyn Edison Co., Brooklyn, N. Y.
Churchman, A. C., General Electric Co., Fort Wayne, Ind.
Cobb, W. O., Public Service Co. of Okla., Tulsa, Okla.
Cockrell, E. A., T. M. E. R. & L. Co., Milwaukee, Wis.
Collins, A. K., F. W. Glassel Co., New York, N. Y.
Connor, W. E., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
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Coursey, R. W., Oklahoma Gas & Electric Co., Oklahoma City, Okla.
Cowles, L. G., Bell Tel. Laboratories, New York, N. Y.
Crampton, R. E., Central Public Service Co., Houghton, Mich
Crawford, D. M., Brooklyn Edison Co., Brooklyn, N. Y.
Crawford, J. M., Shawinigan Water & Power Co., Montreal, Que., Can.
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deMars, P. A., (Fellow), Tufts College, Boston, Mass.
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Deming, P. S., Oklahoma Gas & Electric Co., Seminole, Okla.
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Diaz G., E., Empresa Telef. Ericsson, Mexico City, Mex.
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Dowell, M. F., General Electric Co., Bridgeport, Conn.

Duke, A. M., Union Electric Lt. & Pr. Co., St. Louis, Mo.

Ebbler, F. W., Union Electric Lt. & Pr., Co., St. Louis, Mo.

Eberhard, J. J., General Electric Co., Schenectady, N. Y.

Edmunds, W. M., University of Arizona, Tucson, Ariz.

Ehrmeyer, W. J., Commonwealth Edison Co., Chicago, Ill.

Ellenberger, W. J., United States Bureau of Standards, Washington, D. C.

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Framme, R. J., Bell Tel. Laboratories, New York, N. Y.

Frankenfield, M. W., General Electric Co., Philadelphia, Pa.

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Fretz, O. G., Southwestern Bell Tel. Co., Oklahoma City, Okla.

Fruhner, E. T., American Tel. & Tel. Co., New York, N. Y.

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Granbois, K. J., Penna. Water & Power Co., Holtwood, Pa.

Gray, A. W., R. C. A. Communications, Inc., Bolinas, Calif.

Greenwood, J., 507 West St., New York, N. Y.

Grueter, F. J., National Electric Light Association, New York, N. Y.

Gunther, E. T., General Cable Corp., Dallas, Tex.

Hall, G. O., General Electric Co., Schenectady, N. Y.

Hamilton, R. W., Dominion Electric Protection Co., Montreal, Que., Can.

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Hammond, H. K., Metropolitan Edison Co., Reading, Pa.

Handley, W. H., United Engineers & Constructors, Inc., Philadelphia, Pa.

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Hearson, L. T., American Tel. & Tel. Co., Chicago, Ill.

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Hill, L. W., (Member), Southern Bell Tel. & Tel. Co., Atlanta, Ga.

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Hutchins, B. M., Penna. Power & Light Co., Allentown, Pa.

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Lear, C. M., General Electric Co., Schenectady, N. Y.

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Malkin, A., Ross & MacDonald, Inc., Montreal, Que., Can.

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Marr, J. S., Michigan Alkali Co., Wyandotte, Mich.

Maseng, T., Byllesby Engg. & Mgt. Corp., Chicago, Ill.

Massenburg, W. B., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Mattson, W. W., Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.

Maurer, G. P., The Falk Corp., Milwaukee, Wis.

Maxwell, A. F., Lake Erie Pr. & Lt. Co., Fremont, Ohio

Maynard, N. A., Associated Gas & Electric System, Cambridge, Mass.

McCammon, J. W., (Member), Beauharnois Power Corp., Montreal, Que., Can.

McDonald, C. J., Western Electric Co., Chicago, Ill.

McKinney, J. H., (Member), Dept. of Commerce, Dallas, Tex.

Mellrud, H. E., Commonwealth Edison Co., Chicago, Ill.

Menendez, R. A., Milwaukee Electric Ry. & Lt. Co., Milwaukee, Wis.

Metcalfe, D., American Tel. & Tel. Co., New York, N. Y.

Metz, H. E., Landers, Frary & Clark, New Britain, Conn.

Mier, F. O., J. F. Azcarate S. en C., Mexico City, Mex.

Miles, L. F., Station WHP, Harrisburg, Pa.

Miller, E. H., Kansas Gas & Electric Co., Wichita, Kans.

Millmann, E. H., Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Mitchell, O. V., U. S. Patent Office, Washington, D. C.

Morningstern, W. B., Western Electric Co., Kearny, N. J.

Mowry, K. W., Allied Engineers, Inc., Grand Rapids, Mich.

Mueller, R., Bell Telephone Laboratories, New York, N. Y.

Murray, W. K., General Electric Co., Schenectady, N. Y.

Newman, A. F., Ford Motor Co., Dearborn, Mich.

Nordling, H. G., Alaska Juneau Gold Mining Co., Juneau, Alaska

Norris, C. B., Tulane University, New Orleans, La.

Orrell, H., Diehl Mfg. Co., Elizabethport, N. J.

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Parker, W. H., Jr., Mass. Inst. of Technology, Cambridge, Mass.

Parrott, W. G., Jr., Tennessee Electric Power Co., Chattanooga, Tenn.

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Pfeiff, C. A., Warner Bros., Studios, Brooklyn, N. Y.

Pickslay, W. M., Jr., Allis-Chalmers Mfg. Co., West Allis, Wis.

Porter, L. F., New York Edison Co., New York, N. Y.

Protzman, R. E., New York & Queens Elec. Lt. & Pr. Co., Flushing, N. Y.

Quirino, F., Allen-Bradley Co., Milwaukee, Wis.

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Record, L. E., General Electric Co., Schenectady, N. Y.

Reed, J. F., Jr., Bell Tel. Co. of Pa., Pittsburgh, Pa.

Reeves, W. O., Atlantic Refining Co., Philadelphia, Pa.

Richards, W. N., N. Snellenburg & Co., Philadelphia, Pa.

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Robert, L. W., Jr., Robert & Co., Inc., Atlanta, Ga.

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Robinson, L. L., Worcester Polytechnic Institute, Worcester, Mass.

Roede, C. B., Sperry Products, Inc., Brooklyn, N. Y.

Rosti, A., Route 3, Kellerton, Ia.

Roth, C. W., Roth Bros. & Co., Chicago, Ill.

Roush, C. G., Westinghouse Elec. & Mfg. Co., Kansas City, Mo.

Rummel, G. A., Jr., Chicago Surface Lines, Chicago, Ill.

Russell, A. W., Buckeye Cotton Oil Co., Memphis, Tenn.

Russell, W. F., Hall & Connolly, Inc., New York, N. Y.

Sailer, L. R., Columbia University, New York, N. Y.

Saylor, E. R., General Electric Co., Schenectady, N. Y.

Scheuerman, E. W., Pillar Electric Co., Chicago, Ill.

Schmidt, P. C., New York Edison Co., New York, N. Y.

Scoville, M. E., General Electric Co., Schenectady, N. Y.

Shafer, A. J., Wisconsin Pr. & Lt. Co., Madison, Wis.

Shaw, J., 304 Denton Ave., Lynbrook, N. Y.

Shaw, W. H., Houston Lighting & Power Co., Houston, Tex.
Skipper, E. M., Locke Insulator Corp., Baltimore, Md.
Smith, D. E., Oklahoma Gas & Electric Co., Bristow, Okla.
Somers, F. J., Bell Telephone Laboratories, Inc., New York, N. Y.
Sowers, L. K., General Electric Co., Schenectady, N. Y.
Stay, C. A., United Electric Lt. & Pr. Co., New York, N. Y.
Stiles, M. R., Bell Telephone Laboratories, New York, N. Y.
Stoddard, H. E., Thomson Gibb Elec. Welding Co., Lynn, Mass.
Stoker, J., 156 N. Grant St., Lafayette, Ind.
Stoody, R. E., Cline Electric Mfg. Co., Chicago, Ill.
Sullivan, T. H., Ruggles-Klingemann Mfg. Co., Salem, Mass.
Sweet, A. L., General Electric Co., Schenectady, N. Y.
Swerdlow, N., General Electric Co., Philadelphia, Pa.
Taylor, R. S., Philadelphia Electric Co., Philadelphia, Pa.
Teker, J. W., General Electric Co., Erie, Pa.
Teuscher, F. P., Hydroelectrica Guanajuatense S. A., Mexico, D. F., Mex.
Theophilus, R. H., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Thompson, H. M., Hollis French & Allen Hubbard, Engrs., Boston, Mass.
Thompson, P. S., General Cable Corp., Fort Wayne, Ind.
Torgersen, H., New York University, New York, N. Y.
Valier, C. E., Jr., Southwestern Bell Tel. Co., St. Louis, Mo.
Vartdal, V. K., Western Electric Co., Inc., Kearny, N. J.
Vaughan, C. F., General Electric Co., Pittsfield, Mass.
Viola, A. G., Wagner Electric Corp., St. Louis, Mo.
Wall, C. T., The Northwestern Bell Tel. Co., Minneapolis, Minn.
Watson, H. E., Columbia Engg. & Mgt. Corp., Cincinnati, Ohio
Way, D. M., General Electric Co., Schenectady, N. Y.
Webb, C. C., Armstrong Cork Co., Lancaster, Pa.
Weigle, R. M., General Electric Co., Erie, Pa.
Wheeler, L. B., Western Union Telegraph Co., New York, N. Y.
Wilkins, W. G., Key Boiler Equipment Co., East St. Louis, Ill.
Willoch, H., Alan Wood Steel Co., Conshohocken, Pa.
Wilson, T. A., General Electric Co., Pittsfield, Mass.
Winckler, R. H., Public Service Elec. & Gas Co., Roseland, N. J.
Wisbon, C. B., Lake Erie Pr. & Lt. Co., Fremont, Ohio
Wortman, W. J., General Electric Co., Schenectady, N. Y.
Wright, O. C., St. Louis Public Service Co., St. Louis, Mo.
(Applicant for re-election)
Wurzbach, H. A., American Tel. & Tel. Co., Denver, Colo.
Total 234

Foreign

Federici, M. E., International Tel. & Tel. Lab., Inc., London, Eng.
Gillon, E. G., University of Louvain, Louvain, Belgium
Hayward, G. B., Ebro Irrigation & Power Co., Lerida, Spain
Kahale, N., Tramways & Electricite de Damas, Damascus, Syria
Miridjanian, N. M., Columbia Graphophone Co., Istanbul, Turkey
Nakashidze, D. M., (Prince), Ford Motor Co. Exp., Inc., Istanbul, Turkey
Roy, B. B., Ahmedabad Electricity Co., Ltd., Ahmedabad, India
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Industrial Notes

Condit Offices in New Home.—The Condit Electrical Manufacturing Corporation has moved its sales and executive offices to the new administration building at Hyde Park, Mass.

Electrad Appoints Millard Van Blaricom.—The development of its amplifier business necessitating the enlargement of the technical staff, Millard Van Blaricom, expert in amplifying systems, has been appointed, according to a statement by Arthur Moss, president of Electrad, Inc., New York.

Westinghouse in Refrigeration Field.—Distribution of the Westinghouse refrigerator to all parts of the United States east of Kansas City will be begun at once, according to an announcement by Carl D. Taylor, manager of the refrigeration department of the Westinghouse Electric and Manufacturing Company. During 1930 the refrigerator has been distributed and sold in a gradually increasing area in the east.

Roebling Absorbs New Jersey Wire Cloth Company.—According to a recent announcement, the New Jersey Wire Cloth Company will cease its corporate existence on January 1, and the business will be continued by the John A. Roebling's Sons Company. The New Jersey Wire Cloth Company, now a subsidiary of the Roebling Company, manufactures wire cloth, wire netting, wire fences, etc., the sale of which will be continued through the parent company and other Roebling branches.

Grounding Devices.—Bulletin, 36 pp., "Principles of Grounding." Presents methods of grounding electrical apparatus and auxiliary equipment. A typical ground bus for an outdoor substation is illustrated, embodying recommendations of N. E. L. A. committees. Types of Burndy connectors for diverse applications are shown, as well as connectors used for copper or aluminum tube, cable or bar. Burndy Engineering Co., Inc., 230 East 45th Street, New York.

New G. E. Plastic Department.—The various plastic activities of the General Electric Company have been coordinated into one department known as the plastic department according to an announcement by Gerard Swope, president of the company. R. E. Coleman has been appointed manager of the new department with an advisory committee consisting of vice-presidents J. G. Barry, chairman, W. R. Burrows, and C. E. Eveleth. The new department will be responsible for sales, engineering and manufacturing of plastics and involves activities at the Pittsfield, Schenectady, Fort Wayne, Erie and Lynn (River) plants of the company.

New Power Amplifiers.—Electrad, Inc., 175 Varick Street, New York, has announced the addition of two newly perfected power amplifiers utilizing the revolutionary Loftin-White direct-coupled system which, with their model A-245, completes a line of amplifiers suitable for the present-day requirements of sound amplification of all types. These Electrad direct-coupled amplifiers are readily adaptable to all usual requirements of sound amplification from microphones, phonograph pickups, radio tuners—in fact for all types of amplification at audio frequencies.

NEMA Opposes One Form of Bids on Electrical Equipment.—Opposition to the practice of requiring detailed working drawings with bids on electrical equipment or as an element of contract, was expressed in a resolution adopted November 21 by the Executive Committee of the National Electrical Manufacturers Association. The resolution is as follows:

WHEREAS: The practice of requiring detailed working drawings with bids or as an element of contract is objectionable and works a hardship on the manufacturer in that there is involved not merely unnecessary expense, but the demand for information and data which are the result of knowledge and experience, and are major elements of the bidder's "Stock in trade," be it RESOLVED: That the National Electrical Manufacturers Association hereby records its formal opposition to the practice.

This opposition does not apply to such outline drawings of apparatus showing overall dimensions, assembly drawings of major components, wiring diagrams, performance data and other diagrams, charts, photographs and instructions as are needed for installation, operation and maintenance purposes.

Trade Literature

Illumination.—Booklet L. P. 102, 40 pp., entitled "Tendencies in Lighting Practice, 1930." Illustrated. General Electric Company, Nela Park, Cleveland, Ohio.

Steam Generating Equipment.—Catalog GC-6, 16 pp. Describes and illustrates the fuel burning and steam generating equipment manufactured by the Combustion Engineering Corporation, 200 Madison Avenue, New York.

Automatic Controller Valves.—Catalog 2002, 20 pp. Describes Bristol's automatic controller valves, motor operated types, including the latest developments for steam, water, air and gas. The Bristol Company, Waterbury, Conn.

The Coordination of Light and Music.—Bulletin L. P. 101, 24 pp. Describes the application of color lighting in motion picture theatres. General Electric Company, Nela Park, Cleveland, Ohio.

Fuse Meter Service Switch.—Bulletin 23, 4 pp. Describes Wadsworth accessible fuse meter switch with range and lighting circuits for new and old residence wiring. Wadsworth Electric Manufacturing Co., Inc., Covington, Ky.

Cars and Car Equipment.—Bulletin 1882, 32 pp. Describes and illustrates twenty-six types of street cars and buses placed in service within the last two years. Westinghouse Electric & Manufacturing Corporation, East Pittsburgh, Penna.

Ash Storage Tanks.—Bulletin, 16 pp. Describes vitrified glazed tile, ash storage tanks, providing complete facilities of ash storage for all types of ash conveyor systems. United Conveyor Corporation, Old Colony Building, Chicago, Ill.

Automatic Reclosing Equipment.—Bulletin 20508, 4 pp. Describes Westinghouse type FO-22 outdoor automatic reclosing equipment, designed for use on feeder circuits. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Penna.

Tachometers.—Catalog 46, 16 pp. Describes Brown electric indicating and recording tachometers. These instruments consist of the indicating, recording or automatic control instrument, tachometer generator, wiring between generator and instrument. The generator can be connected to the driving shaft through gears, pulleys, chain or flexible coupling. The Brown Instrument Company, Philadelphia, Penna.

Small Motors.—Bulletin 1883, 16 pp. Describes the various types of Westinghouse small power motors. Illustrations show the construction details of the motors and some of their many applications. Another feature of this publication is a description of the sentinal breaker, a compact starting switch that provides overload protection for fractional horsepower motors. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Penna.